UVIC

DOCTORAL THESIS

The influence of sport and physical activity involvement on health related behaviours during the transition from late adolescence to early adulthood.

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A thesis submitted for the degree of Doctor of Welfare, Health and Quality of Life.

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A dissertation submitted to the University of Vic-Central University of Catalonia in accordance with the degree of Doctor of health, wellbeing and quality of life. Department of physical activity and sport sciences. May 2015.

“Només amb dubtes t’aproparàs al ritme de les certeses.”

Miquel Martí i Pol.

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ABSTRACT

The influence of sport and physical activity involvement on health related behaviours during the transition from late adolescence to early adulthood.

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Introduction: On the one hand, global studies reveal that a high percentage of adolescents are physically inactive (Hallal et al., 2012). Moreover, evidence suggests that tracking of sport and physical activity is low from adolescence into early adulthood (Kwan et al., 2012). Research emphasises the importance to study during the period of transition from adolescence to adulthood to avoid physical activity decrease and to prevent metabolic syndromes as adults (Ferreira et al., 2005). On the other hand, sports participation in adolescence is not always better at promoting healthy lifestyles than regular physical activity, because some sports are more closely associated with an increased likelihood of substance use (Lisha & Sussman, 2010). In consequence, looking the associations between physical activity levels, sport participation and health related behaviours is fundamental because (i) adherence to an inactive lifestyle can lead to the adoption of other unhealthy lifestyle factors, resulting in a multiple risk behaviour pattern (MacArthur et al., 2012; Tercedor et al., 2007), and (ii) sport participation has been positively associatied to substance use amongst adolescents in different countries (Kwan et al., 2014), it is important to observe whether this relationship occurs in adolescents from Catalonia. **Aims:** Three main studies were conducted during the length of the present thesis. Study 1 aimed (i) to

determine patterns for physical activity and other health-related behaviours (alcohol and tobacco consumption, fruit and vegetable intake) among a representative sample of adolescents (mean age = 16 years) from Osona (Barcelona) and (ii) to identify how adolescents´ lifestyle patterns of 16 years old students relate to physical activity levels in this specific cultural context. Study 2 aimed to find associations between physical activity and sport participation patterns and adherence to health-related behaviours in adolescents and early adults from the county of Osona. Study 3 aimed (i) to identify how sport participation and physical activity levels during high school influence the adoption of other health-related behaviours when adolescents reach university; and (ii) to identify predictors of change of sport participation abandon and decline of physical activity levels. **Methods:** All adolescents born in 1995 from Osona (Barcelona) (n=1558) were invited to participate in the study in 2011 (n=695). In 2012 (n=668) and 2013 (n=411) they were followed through high school and university (2014; n=180). Adolescents completed measures of physical activity and health related lifestyle behaviours (tobacco, alcohol, fruit and vegetable intake and sedentary behaviour). Data was analysed using PASW Statistics 18; Descriptive statistics were used to assess patterns and prevalence of physical activity, sport participation and health related behaviours. Chi Square tests, Kruskal-Wallis test and logistic regression were used to assess associations between physical activity, sport participation and health related behaviours. **Results:** Study 1 found (i) low percentage of adolescents from Osona achieved current physical activity recommendations for health (60 daily minutes of moderate to vigorous physical activity, WHO, 2010); (ii) higher level of physical activity is associated with a lower tobacco consumption and higher fruit and vegetable intake. Study 2 found (i) sport participation is an important behaviour to maintain adolescents

active during the transition from adolescence to early adulthood; (ii) positive associations ($p \leq .05$) were found between substance use (alcohol and cigarette consumption) and sport participation among amateur athletes' males across the three years of the study; and (iii) sitting time was a prevalent behavior amongst adolescents during weekdays (> 700 minutes per day). Sport participation was significantly associated with screen time. Study 3 found (i) practicing one sport in high school is not associated to the adquisition and maintenance of health related behaviours during late adolescence and early adulthood; (ii) sport abandon during late adolescence may be associated to the acquisition of unhealthy lifestyles during early adulthood; and (ii) the decrease observed in physical activity levels at leisure time may be related to an increase of time doing inactive hobbies, especially among females. **Discussion:** The sharp decrease of adolescents meeting the recommendations of physical activity through adolescence and early adulthood is a matter of concern. Promoting sport participation among adolescents seems to be a good strategy to maintain physical activity levels in adolescents. Participating in sports -particularly team sports- was associated to higher alcohol consumption and cigarette consumption, especially among males; this association remain stable across the waves. Fruit and vegetable intake among adolescents is low in all the years, although sport participants tend to reach more often the fruit and vegetable recommendations. Sitting time is prevalent among adolescents and specific domains of sedentary behaviour are linked to physical activity. These results emphasize the importance to promotoe sport participation in adolescence, but also the importance of sport clubs (including coaches, venue and management team) to promote the acquisition and maintenance of health related behaviours.

ABSTRACT (CATALA VERSION)

La influència de la pràctica esportiva i de l'activitat física en l'adquisició i el manteniment d'estils de vida saludables en el pas de l'adolescència a l'edat adulta.

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Introducció: La inactivitat física és un factor de risc molt important que contribueix a l'aparició de malalties cròniques tant en l'adolescència com en l'edat adulta (Buchan et al., 2011; Colberg et al., 2010). En els darrers anys, diferents estudis han demostrat que un percentatge molt elevat dels adolescents i joves que viuen en països industrialitzats, no assoleixen els mínims recomanats d'activitat física (60 minuts diaris d'activitat física moderada o vigorosa) (WHO, 2010; Hallal et al., 2012). Una de les activitats essencials que ajuda els adolescents i joves a assolir aquests mínims, és la pràctica esportiva (Pfeiffer et al., 2006), entesa com una activitat física organitzada, planificada i repetitiva, duta a terme en un marc reglamentat i competitiu (Australian Sports, 2013). Un cop demostrat que tant els nivells d'activitat física com de pràctica esportiva disminueixen en el pas de l'adolescència a l'edat adulta (Kwan et al., 2012), la recerca remarca la importància d'estudiar com canvien els nivells d'activitat física en aquesta franja d'edat, per la rellevància que això comporta per a la salut de la població (Ferreira et al., 2005). Per altra banda, la pràctica esportiva no sempre és més eficaç alhora de promoure altres estils de vida saludables, que la pràctica regular d'activitat física, ja que alguns esports estan associats a un major consum de substàncies nocives (Lisha & Sussman, 2010). En conseqüència, estudiar les associacions entre activitat

física, pràctica esportiva i estils de vida en l'adolescència és fonamental perquè (i) nivells baixos d'activitat física poden portar a l'adquisició d'altres estils de vida poc saludables, provocant múltiples factors de risc per a la salut dels adolescents (MacArthur et al., 2012; Tercedor et al., 2007); i (ii) la pràctica esportiva està vinculada amb estils de vida poc saludables, com el consum d'alcohol, en diferents països (Kwan et al., 2014); en aquest context, és important entendre com s'estableix la relació en els adolescents d'Osona. **Objectius:** Durant la realització d'aquesta tesis, es van portar a terme 3 estudis principals. L'estudi 1 tenia l'objectiu de (i) determinar nivells i prevalença d'activitat física i estils de vida (consum d'alcohol i tabac i consum de fruita i verdura) en una mostra representativa d'adolescents (edat mitja = 16 anys) d'Osona (Barcelona) i (ii) identificar com els estils de vida d'aquests adolescents d'Osona es relacionaven amb els seus nivells d'activitat física. L'estudi 2 tenia l'objectiu de trobar associacions entre nivells d'activitat física i pràctica esportiva amb l'adquisició d'estils de vida saludables en el pas de l'adolescència a l'edat adulta (del 16 als 19 anys). Finalment l'estudi 3 tenia l'objectiu de (i) identificar com la pràctica esportiva o l'activitat física durant el primer any de batxillerat influenciava en l'adquisició i el manteniment d'estils de vida fins que aquests adolescents arriben a la universitat i (ii) identificar quins factors poden influenciar en l'abandó de la pràctica esportiva i la reducció dels nivells d'activitat física. **Metodologia:** Tots els adolescents nascuts l'any 1995 a Osona (n=1558) varen ser invitats a participar en l'estudi el 2011 (n=695). El 2012 (n=668) i 2013 (n=411) es varen seguir aquest grup d'adolescents fins que arribaren a la universitat (2014; n=180). Els adolescents varen completar mesures referents a activitat física i altres estils de vida (consum de tabac i alcohol, consum de fruita i verdura i temps assegut). Les dades varen ser analitzades utilitzant el programa

estadístic PASW Statistics 18. L'anàlisis descriptiu va servir per determinar patrons i prevalença dels nivells d'activitat física, pràctica esportiva i els estils de vida prèviament definits. El test del Chi quadrat, el Kruskal-Wallis i la regressió logística, varen ser utilitzats per trobar associacions entre les diferents variables estudiades. **Resultats:** En l'estudi 1 es va trobar que (i) un percentatge molt baix d'adolescents d'Osona assolia els mínims d'activitat física recomanats per l'Organització Mundial de la Salut (WHO, 2010); (ii) els nivells alts d'activitat física estaven associats a un menor consum de tabac i una ingesta més elevada de fruita i verdura. A l'estudi 2 es va trobar que (i) la pràctica esportiva és una activitat molt important per mantenir els adolescents actius en la transició de l'adolescència a l'edat adulta; (ii) existeixen associacions positives ($p \leq .05$) entre el consum de substàncies nocives (alcohol i tabac) i la pràctica esportiva en els nois adolescents que practiquen un esport; i (iii) els adolescents d'Osona passen moltes hores al dia realitzant activitats sedentàries (> 700 minuts al dia asseguts de dilluns a divendres); trobàrem que la pràctica esportiva està significativament associada a passar menys temps asseguts davant d'una pantalla. A l'estudi 3 es va trobar que (i) la pràctica d'un esport durant el primer any de batxillerat no està directament associat a l'adquisició i manteniment d'estils de vida saludables en el pas de l'adolescència a l'edat adulta; (ii) tot i així, l'abandó de la pràctica esportiva i els nivells d'activitat física poden comportar l'adquisició d'estils de vida poc saludables quan comencen l'edat adulta; finalment (iii) la forta davallada observada en els nivells d'activitat física durant aquests tres anys pot estar associada a un augment del temps que, sobretot les noies, es passen assegudes realitzant hobbies sedentaris. **Discussió:** Els baixos nivells d'activitat física trobats ens els adolescents d'Osona i la davallada que aquests nivells pateixen en el pas de l'adolescència a l'edat adulta és un motiu de

preocupació. Promoure la pràctica esportiva sembla ser una bona estratègia per mantenir els nivells d'activitat física durant l'adolescència. Per altra banda, la pràctica esportiva –especialment els esports d'equip- en nois, està associada a un major consum d'alcohol i tabac, que es manté estable en els dos anys de batxillerat i el primer any d'universitat. La ingesta de fruita i verdura és, en general, molt per sota els mínims recomanables de 5 porcions al dia, tot i així, aquells adolescents que practiques un esport tendeixen a consumir més fruita i verdura que els altres. Els adolescents d'Osona passen la major part del seu dia asseguts; els resultats indiquen que la pràctica esportiva i d'activitat física pot disminuir el temps assegut que passen els adolescents en algunes activitats concretes. Aquests resultats emfatitzen la importància de promoure la pràctica esportiva durant l'adolescència, però també la importància que tenen els clubs esportius (incloent entrenadors, cos tècnic, coordinadors i junta directiva) a l'hora de promoure l'adquisició i el manteniment d'estils de vida saludables en aquesta edat.

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LIST OF ABBREVIATIONS

Physical Activity (PA)

Moderate to Vigorous Physical Activity (MVPA)

World Health Organization (WHO)

U.S. Department of Health and Human Services (USDHHS)

Metabolic Equivalent of Tasks (MET)

International Physical Activity Questionnaire (IPAQ)

Physical Activity Questionnaire for Adolescents (PAQ-A)

Body Mass Index (BMI)

No Sport participant and Inactive (NSI)

Non Sport participant and Active (NSA)

Individual Sport participants (IS)

Team Sport participants (TS)

Transport (Trans)

American College of Sports Medicine (ACSM)

International Society for Physical Activity and Health (ISPAH)

Centers for Disease Control and Prevention (CDC)

Disability Adjusted Life Years (DALYs)

Food and Agriculture Organization of the United Nations (FAO)

European Food Information Council (EUFIC)

European school Survey Project on Alcohol and other Drugs (ESPAD)

Total Screen Time (TST)

Non-communicable diseases (NCDs)

INTRODUCTION

The numerous health-benefits of engaging in regular physical activity are now generally accepted including a decline in the risk of developing diabetes, stroke, hypertension, coronary heart disease, and breast and colon cancer (Humphreys, McLeod, & Ruseski, 2014; WHO, 2014). In adolescents, associations have been identified between achieving physical activity recommendations and (i) showing higher levels of cardiorespiratory fitness, muscular endurance and muscular strength, (ii) enhanced bone health, (iii) reduced body fat, (iv) lower blood pressure, (v) having a better cardiovascular and metabolic risk profile and, (vi) showing reduced symptoms of anxiety and depression (Janssen & Leblanc, 2010; Buchan et al., 2011). However, a high percentage of adolescents in industrialised countries are physically inactive (Hallal et al., 2012). In Spain, over 50% of the girls and 30% of the boys failed to achieve current physical activity recommendations (60 min/day of moderate to vigororus physical activity) (Gracia-Marco et al., 2011; Tercedor et al., 2007). Moreover, levels of physical activity decline during the transition point from adolescence to early adulthood (Kwan et al., 2012). Yet, sport participation is likely to contribute to achieve and maintain the minimum recommendations of physical activity among youth and across adulthood (Nelson et al., 2005; Ekelund et al., 2011).

Cross-sectional and longitudinal associations between physical activity, sport participation, and other health-related behaviours (cigarette and alcohol consumption, fruit and vegetable intake and sedentary behaviour) has shown mixed results (Delisle et al., 2010; Musselman & Ruledge, 2010; Melkevik et al., 2010). Catalan current

health plans pretend to promote healthy lifestyles in all levels and areas, encouraging the adoption of healthy lifestyles to counteract actual harmful lifestyle behaviours that have a high cost to public health (Torralba, 2014). In this context, cross-sectional and longitudinal studies analysing the prevalence and tracking of physical activity through late adolescence and early adulthood and finding how an active or inactive lifestyle associates to other health related behaviours are necessary. Longitudinal studies finding these prevalences and associations are scarce in Spain and Catalonia.

In this context, the study aims to describe levels of physical activity and sport participation among a group of adolescents followed from 15 to 19 years old, and to observe how physical activity and prevalence of sport participation relates to other health-related behaviours (cigarette and alcohol consumption, fruit and vegetable intake and sedentary behaviour). Thus, the research objectives for the PhD thesis were the following:

1. To establish descriptive baseline data for patterns of physical activity, sport participation, cigarette and alcohol consumption, fruit and vegetable intake and sedentary behaviour among a representative sample of 16 years old teenagers from Osona (Barcelona) doing their last year of compulsory secondary school (Study 1).
2. To examine how patterns of health-related behaviours change from adolescence to early adulthood in a representative sample of teenagers from Osona (Barcelona) in their first year of University (Study 2).

3. To study longitudinal associations between levels of PA and prevalence of sport participation with cigarette and alcohol consumption, fruit and vegetable intake and sedentary behaviour (Study 3).

A quantitative approach was used to investigate the topic under study as it is appropriate to investigates possible relationships between phenomena in order to establish if correlation exists and, if so, to which extent (Walliman, 2011). The quantitative design included two different stages: (i) a cross-sectional study that provided a description of lifestyle behaviours patterns in adolescents from Osona; and (ii) a longitudinal study that examined changes in lifestyle patterns across three years (from 16 to 19 years of age) and how these changes related to changes in physical activity patterns and sport participation over the same period.

The present thesis will provide descriptive information to design effective health promotion strategies for adolescents and young adults from Spain and Catalonia; contributing to achieve current targets for the adoption and maintenance of health-related behaviours during this key transition period of peoples´ life.

CHAPTER 1.

BACKGROUND

CHAPTER 1. BACKGROUND

Glossary of key terms

This glossary of key terms has been developed to clarify concepts and to reduce terminological confusion among the terms most frequently used in the area of physical activity and health. Terms that have used in this PhD thesis are grouped by the following categories: (i) Subsets of Physical Activity (ii) Dimensions of Physical Activity, (iii) Domains of physical activity, (iv) Sedentary time, (v) Domains of Sedentary time (vi) Health promotion (vii) chronic diseases (vii) behaviour change.

Table 1. *Glossary of key terms encountered in the PhD thesis by categories*

Subsets of physical activity	Reference
Physical Activity: Any bodily movement produced by skeletal muscles that require energy expenditure above the resting metabolic rate.	WHO, 2010
Physical inactivity: A term used to identify people who do not meet the existing guidelines of PA (3 or more days of vigorous activity during the last week, consisting of at least 20 minutes per day; or 5 or more days of moderate-intensity activity or walking during the last week, consisting of at least 30 minutes per day; or 5 or more days of any combination of walking, moderate-, or vigorous-intensity activities during the last week).	Guthold et al. 2008
Sport participation: A human activity capable of achieving a result requiring physical exertion and/or physical skill, which, by its nature and organization, is competitive and is generally accepted as being a sport.	Australian Sports, 2013
Exercise: A subcategory of physical activity which is planned, structured, repetitive, and purposeful in the sense that the objective is the improvement or maintenance of one or more components of physical fitness.	WHO, 2010

Physical Fitness: The ability to carry out daily tasks with vigour and alertness, without undue fatigue and with ample energy to enjoy leisure-time pursuits and meet unforeseen emergencies. Physical fitness includes a number of components consisting of cardiorespiratory endurance (aerobic power), skeletal muscle endurance, skeletal muscle strength, skeletal muscle power, flexibility, balance, speed of movement, reaction time, and body composition.	USDHHS, 2008
Borg Scale: A scale for ratings of perceived exertion (RPE). It is a tool for estimating effort and exertion, breathlessness, and fatigue during physical activity. The Borg scale is a category-ratio scale anchored at the number 10, which represents extreme intensities.	Borg, 1998
The Metabolic Equivalent of Tasks (MET): A unit used to estimate the amount of oxygen used by the body during PA. 1 MET is the energy used by the body at rest, while sitting quietly or reading a book and it is equivalent to oxygen consumption of about 3.5mL O_2 $kg^{-1}.min^{-1}$. The harder your body works during the activity, the more oxygen is consumed and the higher the MET level.	Quinn, 2014
Dimensions of physical activity	
Intensity of physical activity: Intensity refers to the rate at which the activity is being performed or the magnitude of the effort required performing an activity or exercising.	WHO, 2010
Low-intensity physical activity: An aerobic activity that does not cause a noticeable change in breathing rate. On an absolute scale, low intensity refers to the PA that is performed at less than 3.0 times the intensity of rest. On a scale relative to an individual's personal capacity (how hard an individual feels he or she is exercising), low-intensity PA is usually a 3 or 4 on a scale of 0–10.	USDHHS, 1999; Norton et al., 2010
Moderate-intensity physical activity: An aerobic activity that it is able to be conducted whilst maintaining a conversation uninterrupted. On an absolute scale, moderate intensity refers to the PA that is performed at 3.0–5.9 times the intensity of rest. On a scale relative to an individual's personal capacity, moderate-intensity PA is usually a 5 or 6 on a scale of 0–10	WHO, 2010; Norton et al. 2010.

Vigorous-intensity physical activity: An aerobic activity in which a conversation generally cannot be maintained uninterrupted. On an absolute scale, vigorous intensity refers to PA that is performed at 6.0 or more times the intensity of rest. On a scale relative to an individual's personal capacity, vigorous-intensity PA is usually a 7 or 8 on a scale of 0–10.	WHO, 2010; Norton et al. 2010
Domains of physical activity	
Physical activity domains: Physical activity levels can be assessed in various domains, including one of more of the following: leisure-time activity, occupational activity (doing PA at work and active commuting), household activity (domestic activities), and activity as a way of transport (walking or cycling for transport).	WHO,2010; Samitz, Egger, & Zwahlen, 2011
Leisure-time physical activity: PA performed by an individual that is not required as an essential activity of daily living and is performed at the discretion of the individual. Such activities include exercise conditioning, and recreational activities such as going for a walk, dancing, and gardening.	WHO, 2010
Transport domain: Walking and cycling for transport.	Sallis et al. 2004
Domestic domain: Activities that involve energy expenditure and are performed at home (i.e. washing floors or vacuuming).	Bull et al. 2004
Work/school domain: Activities that involve energy expenditure and are performed at work or school (i.e. moving things from one place to another).	Bull et al. 2004
Sedentary time	
Sedentary Behaviour: Any waking behaviour characterized by an energy expenditure ≤1.5 METs while in a sitting or reclining posture.	Sedentary behaviour, 2012
Domains of sedentary time	
Screen time: The time spent in front of an electronic device. In the present study screen time includes television, video games, DVD movies, email, and non-school related computer usage.	Hardy et al. 2010
Passive transport: Motorized transport.	Sallis et al. 2004
Workplace (or school) sitting: Time spent sitting at work and/or school.	Owen et al. 2010

Health related behaviours items	
Health: a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.	WHO, 2010
Health behaviours: Any activity undertaken for the purpose of preventing or detecting disease or for improving health and wellbeing. Some of the most prevalent health behaviours are: exercise, smoking, diet and alcohol use.	Conner, 2002
Health promotion: Is the process of enabling people to increase control over, and to improve, their health.	WHO, 2010
Public health: Public health refers to all organized measures (whether public or private) to prevent disease, promote health, and prolong life among the population as a whole.	WHO, 2010
Chronic disease	
Non-communicable diseases: Also known as chronic diseases, non-communicable diseases are a medical condition that can be defined as non-infectious and non-transmissible among people. They are of long duration and generally slow progression. The 4 main types of non-communicable diseases are cardiovascular diseases (like heart attacks and stroke), cancers, chronic respiratory diseases (such as chronic obstructed pulmonary disease and asthma) and diabetes.	WHO, 2015.
Behaviour change	
Tracking: The tendency of individuals to maintain their rank or position within a group over time.	Malina, 2001
Transition: The process or a period of changing from one state or condition to another.	Oxford Dictionaries, n.d.
Adherence: The extent to which a person's behaviour – taking medication, following a diet, and/or executing lifestyle changes, corresponds with agreed recommendations from a health care provider.	WHO, 2003

Adult population health in modern societies: Key issues

In the last period of the 20th century, non-communicable diseases (NCDs) showed the largest population reach (Kohl & Murray, 2012), being the major cause of adult mortality and morbidity worldwide (WHO, 2014). Four major NCDs are responsible for 82% of NCD related deaths: cardiovascular diseases (46.2%), cancer (21.7%), chronic respiratory diseases (10.7%) and diabetis (4%). In 2010, the NCDs-related global burden of disease was quantified in 1.3 billion of years of life lost due to premature mortality and disability (DALYs); with 40% of the lost years occurring in adults between 30-59 years of age.

In Spain, 9 million of NCDs-related DALYs were quantified over the same year; with 35.5% of the lost years happening in the working-age population (Institute for Health Metrics and Evaluation, 2014). This is the result of the increased prevalence of NCDs among the Spanish population over the last three decades (Ministerio de Sanidad, Servivios Sociales e Igualdad, 2013). While in 1987 obesity affected 7.4% of Spanish adults; in 2012 this percentage increased to 17%. Similar increases have been shown since 1993 regarding hypertension (+7.3%), high cholesterol (+8.2%) and diabetes (+2.9%) (Ministerio de Sanidad, Servivios Sociales e Igualdad, 2013). In this context, it is important to develop and implement policies and interventions to prevent and control NCDs among the population (WHO, 2013b).

The increase in the prevalence of NCDs has been partly caused by detrimental changes in people´s lifestyle (Mendis, Puska, & Norriving, 2011). Tobacco use, physical inactivity, the harmful use of alcohol and unhealthy diets have been defined as

modifiable behavioral risk factors that increase the risk of NCDs (WHO, 2014). Low-cost solutions to reduce NCDs exist by dimishing these common modifiable risk factors (WHO, 2014).

According to health promotion theory (Kemm & Close, 1995), enabling people to control over the determinants of health (health behaviours, lifestyles and living conditions) is a key strategy to improve population´s health (Kemm & Close, 1995; Hallal et al., 2012). However, health promotion not only embraces actions directed at strengthening the skills and capabilities of individuals, but also action directed towards changing social, environmental and economic conditions, to alleviate their impact on public and individual health (Kickbusch & Nutbeam, 1985).

In this regard, several public health policies including the Ottawa Charter (WHO, 1986), the Jakarta Declaration (WHO, 1997), the Global Strategy on diet, physical activity and health (WHO, 2004b), the NAOS strategy in Spain (Ministerio de Sanidad y Consumo, 2005) and, the recent Global Action Plan for the prevention and control of NCDs 2013-2020 (WHO, 2013b) have set targets and planned actions to improve the population´s adoption and adherence to healthy behaviours.

In the Global Action Plan 2013-2020, targets for prevention and control of NCDs to be attained by 2025 include a 10% relative reduction in the prevalence of insufficient physical activity (PA), a 10% relative reduction in the prevalence of the harmful use of alcohol and, a 30% relative reduction of current tobacco use (WHO, 2013b). These targets need to be achieved within each national context (WHO, 2014) because, based on the ecological model, social, physical and policy environments impact on the ability or likelihood of individuals participating in PA (Giles-Corti & Donovan, 2002).

Therefore, adopting healthy lifestyle behaviours is influenced by contextual factors specific from each country and each region (WHO, 2014).

In Spain, recent health plans aimed to promote health and well-being of the population by empowering individuals' health and creating safe and healthy environments for the population (Ministerio de Sanidad, Servicios Sociales e Igualdad, 2014). This action plan gives special relevance to promote healthy lifestyle behaviours (PA, fruit and vegetable intake, less alcohol and tobacco consumption) and healthy environments (i.e. more green areas, more walking paths) by 2020 in order to increase the life expectancy (>2 years) and the quality of life of the Spanish population (Ministerio de Sanidad, Servicios Sociales e Igualdad, 2014). In this context, one of the main strategies conducted in Spain is the NAOS strategy which aimed to encourage healthy eating and promote PA to reverse the upward trend in the prevalence of obesity observed in the Spanish population and thereby, reduce the prevalence of morbidity and mortality attributable to NCDs (Ministerio de Sanidad y Consumo, 2005).

In Catalonia, the current health plan for 2020 sets a target to increase 5% the life expectancy lived in a good health in Catalan men and women from this nation. Moreover they plan to reduce the mortality due to cardiovascular disease (20%) and cancer (10%) and the amputation-related diabetes (10%) by 2020 (Departament de Salut, 2012). One of the main courses of action proposed by the Catalan health plan is to strengthen health promotion and disease prevention programs, in order to reduce the prevalence of NCDs among the population, with cost-effective interventions. Specifically they pretend to increase 10% the people achieving the MVPA recommendations, to reduce the prevalence of tobacco consumption under 28%, and

to reduce the prevalence of overweight and obesity below the actual levels (35.3% and 12.0%) (Departament de Salut, 2012).

To attain these goals, the Catalan government developed the PAFES program (Programa d'Activitat Física Esport I Salut). This program aims to improve the health of the Catalan population through PA (Generalitat de Catalunya, 2015), based in the previously mentioned ecological model (Sallis et al., 2008). Other strategies have been also developed such as the PAAS program (Pla Integral per a la Promoció de l'Activitat Física I l'Alimentació Saludale) which plan actions to promote health through PA and health by raising awareness and promoting cooperation strategies between different areas (educational, community, sanitary and companies) (Generalitat de Catalunya, 2008), the AMED program (Programa de Promoció de l'Alimentació Mediterranea) which aims to promote the Mediterranean diet as a model of healthy eating among the Catalan population (Agència de Salut Pública de Catalunya, 2015), and the PEFS program (Guia de Prescripció d'Exercici Físic per a la salut) which aims to make health professionals aware about the importance to promote PA as an essential tool to prevent and treat NCDs in industrialized countries (Direcció general de salut pública, 2007). In this context more than 2,000 primary health care professionals will be trained in 2015 in the training course "Be active, advise health" to enhance PA in the general population (Ministerio de Sanidad, servicios sociales e igualdad, 2015).

Benefits and prevalence of physical activity in adults

Achieving current recommended levels of PA during adulthood (a minimum of 150 minutes per week of moderate PA or 75 minutes of vigorous intensity PA per week) (WHO, 2010) – either as part of house chores, active transportation, working, playing or doing sport - is one of the most important conditions to maintain adult´s mental, physical and social health (Bouchard, Blair, & Hasko, 2007; Malina, 2006; Kohl et al., 2012; WHO, 2010). Numerous health benefits have been reported from achieving current PA recommendations including a decline in the risk of developing diabetes, stroke, hypertension, coronary heart disease, and breast and colon cancer from 20% to 30%. (Warburton, Nicol, & Bredin, 2006; Humphreys, McLeod, & Ruseski, 2014; WHO, 2014).

Several studies illustrate these benefits. Individuals who exercised an average of 92 min per week or 15 min a day reported a 14% reduced risk of all-cause mortality and a 3 year longer life expectancy (Wen et al., 2011). A recent study observed that physical inactivity caused 10% of breast and colon cancers worldwide (Lee et al., 2012); for every additional 15 min of daily exercise, all-cause and all-cancer mortality was reduced by 4% and 1% respectively (Wen et al., 2011), A systematic review confirmed that moderate to vigorous additional PA of about 2,000 to 3,000 kcal per week appear to reduce the overall risk for CHD, stroke and other diseases (e.g. hypertension) (Reiner, Niermann, Jekauc, & Woll, 2013). In patients with a diagnose of type 2 diabetes, high levels of PA improved glycaemic control and reduced visceral adipose tissue, plasma triglycerides and medication dose (Thomas, Elliot, & Naughton, 2006; Reiner at al., 2013). Moreover, the proportion of the ischaemic heart disease disability-

adjusted-life-years attributable to physical inactivity is 31.0% (Lim et al., 2013). Overall, in 2010, physical inactivity caused 69.3 million DALYs -2,8% of the total- worldwide (WHO, 2014) and in Spain is estimated that 13.4% of all the deaths occurred in this country could be avoided if all the inactive population started to meet the PA guidelines (Ministerio de Sanidad, Servicios Sociales e Igualdad, 2014). Other health benefits have been linked to achieving PA recommendations such as psychological benefits including depression and dementia (Adeniyi, Okafor, Adeniyi, 2011; Janssen & Leblanc, 2010; Reiner et al., 2013), preventing risk of falls in the elderly (Sherrington et al., 2008) and reducing the risk of osteoporosis and osteoporotic fractures (Forsyth, Quon, & Konkle, 2011).

From a border perspective, the negative health consequences of not achieving current PA recommendations have been linked to an increase in the economic costs of countries including (i) direct costs which are linked to diseases with costly treatments that imply a high use of drugs and services (doctor's visit and hospitalization) and; (ii) indirect costs such as the number of days with workplace absenteeism and low-productivity (Janssen, 2012). In Australia, physical inactivity cost the health care system Aus$ 1.5 billion per year (Mediabank Private, 2007) and it was suggested that indirect costs would double the direct health care costs related to inactivity (Bauman, Bellew, Vita, Brown, & Owen, 2002). In UK, the total costs for physical inactivity were quantified in £0.9 billion during 2006-07 (Scarborough et al., 2011). In the European countries, including Spain, physical inactivity costs between 150 to 300 Euros per citizenship per year (IESE, 2014). A Catalan study concluded that one euro invested exclusively on PA promotion for each citizen, could save 50 euros/per person/per year in health expenses accumulated over 15 years (Atlas Sport consulting, 2006). Evidence

suggests that a reduction of 10% in adults´ physical inactivity could save around Canadian $150 million (Katzmarzyk et al., 2000).

Despite the physical, mental and socio-economic benefits of achieving current recommendations of PA, physical inactivity is highly prevalent among adults. Worldwide, 31.1% of adults are physically inactive (Hallal, et al., 2012), with the prevalence of physical inactivity being higher in high income countries such as Ireland (35%), Italy (36%), France (42%) and, to a lesser extent, Spain (28%) (Dummith, Hallal, Reis, & Kohl, 2011b). In Europe, 39% of adults (25-69 years old) never exercise or play sport and 14% never do any type of PA such as gardening, dancing or going for a ride (European Comission, 2010). In Spain, 41.2% (46.6% women) of the adult population are inactive during their free time (Ministerio de Sanidad, Servicios Sociales e Igualdad, 2014). In Catalonia, based on a national survey, the percentage of population (15-69 years old) who do not achieve the healthy PA recommendations is 31.4% (35.6% women) (Departament de Salut, 2015). In this context, the previously mentioned aim stated by the health Plan of Catalonia 2020 (i.e. to improve the health of the Catalan population by increasing PA levels around 10%; Generalitat de Catalunya, 2015) is a key target to prevent and control NCDs among the Catalan population.

Prevalence and problems related to tobacco consumption in adults

Tobacco consumption is a lifestyle behaviour that negatively affects adults´ health (USDHHS, 2014) being the single most important cause of chronic obstructive pulmonary disease and the second leading risk factors for global disease burden (Doll et al., 2004; Lim et al., 2013). Smoking damages several organs of the body (i.e. Trachea, bronchus and lung), causing many diseases (i.e. cancer, chronic obstructive coronary diseases and asthma) in smokers as well as in passive smokers (USDHHS, 2014). A longitudinal study conducted in UK (n=34.439 males) found that regular male smokers born in 1900-1930 died 10 years younger on average than non-smokers (Doll, Peto, Boreham, Sutherland, 2004).

The harming effects for health of tobacco consumption have been reported in several systematic reviews (Lim et al., 2013; Oberg et al., 2011; Huxley and Woodward, 2011). Briefly, smoking consumption has been associated with (i) an increased risk of developing lung cancer in men and women compared to non-smokers (23 and 23 times higher risk respectively (CDC, 2011), (ii) a greater risk of fatal and non-fatal coronary heart disease with smoking for males and females (RRR = 1.25) (Huxley and Woodward, 2011; Teo et al., 2006), (iii) a disruption of the microtubule arrangement in fibroblasts that can inhibit effective healing (Sloan et al., 2010) and, (iv) a significantly increased risk of all-cause mortality (HR = 2.94) (Parsons, Daley, Begh, & Aveyard, 2010). As a result, tobacco kills nearly 6 million people each year worldwide (WHO, 2013). The European Region shows the highest mortality rate attributed to tobacco

consumption (16%) (WHO, 2013). Within Spain, this percentage also remains high (14.7%) (Ministerio de Sanidad, Servicios Sociales e Igualdad, 2014).

In 2012, 28% of EU citizens smoked boxed or hand-rolled cigarettes, cigars or a pipe daily; with citizens in Southern and Eastern Europe (Greece = 40%; Bulgaria = 36%; Latvia = 36%) showing a higher prevalence of smokers than other countries. Spain is the 5th European country with highest prevalence of smoking (33%) among the adult population (European Comission, 2012). In Catalonia, 26.5% of the population over 15 years of age are current smokers, being this percentage higher for men (32.2%) than women (20.9%) (Departament de Salut, 2015).

Despite the gradually reduction of smoking consumption during the last decade (CDC, 2011), one main aim, is a 30% relative reduction in prevalence of current tobacco use worlwide by 2025 (WHO, 2014). In Spain and Catalonia the tendency of tobacco consumption also shows a reduction during the last 10 years (Departament de Salut, 2015; Romero et al., 2012); although ongoing efforts in public health are still needed if the current targets set by the Spanish and Catalan Health Plans for 2020 (reduce prevalence of smokers under 20%) have to be achieved (Comité Nacional para la Prevencion del Tabaquismo, 2009).

Prevalence and problems related to alcohol consumption in adults

Ethanol alcohol is an intoxicating component found in alcoholic beverages such as beer, wine, and spirit liquors (WHO, 2014). Harmful use of alcohol has been globally defined as drinking more than 3-4 units of alcohol per day for men and 2-3 units/day for women, with one unit being defined as 8g of pure alcohol (WHO, 2014c). Alcohol is rapidly absorbed through the stomach and small intestine into the bloodstream, resulting in a depression of the central nervous system. The liver breaks down the alcohol into Acetic Acid, which is the substance that negatively interacts with most organs in the body producing intoxication symptoms (WHO, 2014c). These symptoms stay until the excess of alcohol stops circulating throughout the bloodstream after several hours (±one hour to break down one unit of alcohol) (NIH, 2010).

Harmful alcohol consumption has been linked to the development of more than 200 acute and chronic health conditions (WHO, 2014c) including neuropsychiatric conditions (i.e. depression, autism, and schizophrenia), gastrointestinal diseases (i.e. gastritis, Gastroesophageal reflux disease and pancreatitis), cancers, cardiovascular diseases and infectious diseases such as pneumonia and tuberculosis (WHO, 2014c). Estimates suggest that 5.1% of the global burden of disease and injury measured in DALYs (Disability Adjusted Life Years) was attributable to the harmful use of alcohol consumption. Similarly, 5.9% of all global deaths (3.3 million) in 2012 were attributable to the harmful use of alcohol with a higher percentage shown in men than women (7.6% and 4.0% respectively). These deaths were linked to cardiovascular diseases and diabetes, unintentional injuries, gastrointestinal diseases and cancers (WHO, 2014).

The percentage of alcohol-attributable deaths is higher in 'industrialized countries' including the majority of the European countries (WHO, 2014). In Spain, 8.4% of all female deaths and 12.3% of all male deaths (aged 15 to 64 years old) were attributed to the harmful use of alcohol consumption in 2005 (Rehm et al., 2012); with 79% of the Spanish adult population drinking alcohol in the previous year, 65% drinking alcohol during the last month and 10% drinking alcohol every day (Ministerio de Sanidad, 2015). Of these, 4.9% were drinking alcohol units above the healthy recommendations (Ministerio de Sanidad, 2015). Interestingly, the prevalence of alcohol consumption during the last years remains stable and high (over 60% consumption during the last 30 days) (Ministerio de Sanidad, 2015).

In this context, ongoing efforts to reduce the harmful use of alcohol consumption among Spanish and Catalan adults is needed in order to achieve the Health Plans targets for 2016 by reducing harmful use of alcohol (Agència de Salut Pública de Catalunya, 2013).

Prevalence and problems related to low fruit and vegetables intake in adults

The total-cause mortality currently attributable to inadequate consumption of fruit and vegetables is estimated to be up to 2.635 million deaths per year. Current scientific evidence suggests the importance of fruits and vegetables intake in the prevention of coronary heart disease, stroke, cataract formation, chronic obstructive pulmonary disease, cancer, and hypertension (Hall, Moore, Harper, & Lynch, 2009). Global based studies suggest that increasing fruit and vegetable consumption (≥ 600 g

per day) could reduce the total worldwide burden of disease by 1.8%, and reduce the burden of ischaemic heart disease (31%) and ischaemic stroke (19%). For stomach, oesophageal, lung and colorectal cancer, the potential reductions were 19%, 20%, 12% and 2%, respectively (Lock et al., 2005).

A daily intake of 400g of fruits and vegetables or 5 pieces a day is the current recommendation that has been linked to the prevention of several NCDs, highlighting the prevention of gastrointestinal cancers deaths (14%), ischaemic heart diseases (11%) and stroke deaths (9%) (WHO, 2004; EUFIC, 2012). According to the Food and Agriculture Organization of the United Nations (FAO, 2014) the vegetable and fruit supply in Europe has increased by an annual rate of 3% over the past decade although a vast percentage of the adult population (>80%) fail to achieve the current recommendations (Murphy et al., 2014). A study with 19 different European countries found that only four (Poland, Germany, Italy and Austria) met the recommendation of consuming ≥400 g of fruits and vegetables per day in more than 50% of the adult population (Elmadfa et al., 2009). In Spain, adults consume an average of 225g of vegetables (without potatoes) and 305g of fruit per day (Del Pozo et al., 2012), which, adding fruit and vegetables, surpass the minimum worldwide recommendations of 400g per day (EUFIC, 2012). However, Catalan studies indicate that only 11.7% (13.0% of women) of the Catalans achieve the daily recommendations of fruit and vegetable intake (Departament de Salut, 2015).

Despite the increased consumption of fruits and vegies reported in Mediterranean countries -including Spain and Catalonia- compared to other countries (Murphy et al., 2014; OECD, 2012), an increase of the Catalan population that reach the healthy

recommendations (11.7%) (Departament de Salut, 2015) would result in substantial health benefits such as the prevention of gastrointestinal cancers deaths, ischaemic heart diseases and stroke deaths (EUFIC, 2012).

Prevalence and problems related to sedentary behaviour in adults

Sedentary behaviour is the term used to define low energy expenditure behaviours (MET of 1.5 or less) such as prolonged sitting time (Sedentary Behaviour Research Network, 2012). Recent evidence from a systematic review of a longitudinal studies has found significant associations between spending high volumes of daily time sitting and the development of several health-related problems such as diabetes, site-specific cancers, cardiovascular diseases, symptomatic gallstone disease and mental disorders independently of PA levels (Thorp et al., 2011). Owen (2009) suggests that even when meeting the PA recommendations there may be significant detrimental metabolic and health effects from prolonged sitting (i.e. les blood glucose control). In relation to NCDs, evidence indicates that meeting MVPA guidelines is unlikely to be sufficient to counteract the increases in overweight and obesity over the last 15 years if it is not accompanied by a reduction in sitting time behaviour (Inoue et al., 2012; Bauman et al., 2008; Healy et al., 2007). Sitting time has been also associated with higher central adiposity (Thorp et al., 2009) and an increased risk in all-cause mortality in both men and women (Van Uffelen et al., 2010). Positive associations have been found with sitting time, cardiovascular disease-related mortality and, an increased risk for the

development of diabetes mellitus (Patel et al., 2010; Thorp et al., 2011; Van Uffelen et al., 2010).

Despite the health-related problems associated with prolonged sitting time, prevalence of population´s sitting time among industrialized countries is high (Dunstan, Howard & Owen, 2012; Bauman et al., 2011). Objectively measured data indicate that up to two thirds of adults waking hours are spent sedentary (Dunstan et al., 2012). Self-reported data from Spain indicate that 21% of the Spanish adult population spend more than 9 hours sitting every day (n=1549) (Bauman et al., 2011). A national based survey indicated that the vast majority of the Spanish population (82.6%) spend their working day in a sedentary position (Ministerio de Sanidad, Servicios Sociales e Igualdad, 2013) and the prevalence of Spanish people who spend most of their working time in a sitting position has increased in the last decade (6.8%) (Ministerio de Sanidad, Servicios Sociales e Igualdad, 2013).

Although the evidence is not conclusive about the exact amount of sitting time that is more harmful for health, studies suggest that people who reported >23 hr/wk of combined sedentary behaviour showed a 64% greater risk of dying from CVD than those who reported <11 hr/wk (Warren et al., 2010).Therefore, higher amounts of daily total sitting time are associated with greater risk of all-cause mortality (Chau et al., 2013)

Despite the Health Plans for Spain and Catalonia do not include any targets or actions to reduce sitting time behaviors (Departament de Salut, 2015), reducing this emergent risk behavior that has been consistently linked to the development of several NCDs could significantly contribute to improve the health of Spanish and Catalan adults.

Summary of key issues

- NCDs are the major cause of morbidity and mortality worldwide. The increase in the prevalence of NCDs has been partly caused by detrimental changes in people's lifestyles related to physical activity, harmful use of alcohol, tobacco consumption and unhealthy diet.
- Despite the several benefits of achieving the PA recommendations, 31.1% of adult population worldwide are physically inactive. In Catalonia, the percentage of population (15-69 years old) who do not achieve the healthy PA recommendations is 31.4% (35.6% women).
- Twenty-eight% of the European citizens are current smokers. In Spain the prevalence of smoking is 33%.
- 5.9% of all global deaths in 2012 were attributable to alcohol. In Spain 65% of adults have drunk during the last month.
- Although in general Spanish adults show a better fruit and vegetable intake, only 11.5% of the Catalan population achieve the minimum recommendations.
- Sedentary behaviour is an independent behaviour for the development of NCDs. In industrialized countries up to two thirds of adults waking hours are spent sedentary.
- Adopting healthy lifestyle behaviours is influenced by contextual factors specific from each country and each region and therefore specific programs for each region need to be developed.
- Spanish and Catalan recent health plans aimed to promote health and well-being of the population by empowering individuals' health and creating safe and healthy environments for the population.

Adolescents health in modern societies

During adolescence (from 10 to 18 years of age) several biological (i.e. specific sexual hormones release, developing circulatory and respiratory systems), cognitive (i.e. mental reversibility), psychological (i.e. mood swings, identity construction), social (i.e. family and friends interaction, losing childhood roles) and environmental-related (i.e. changing school, changing place of residence) changes take place (WHO, 2014d; Berger, 2007). These changes influence several aspects of adolescents´ life which result in a modification of adolescents´ patterns including academic, sociological and health issues (Elder, Caspi, & Burton, 2013).

By the time teenagers have completed adolescence, they are as strong and healthy as they ever will be. However, the destructive habits can cause illness, injury or death (Berger, 2007). In this context, the consumption of drugs, the poor diet and the low levels of PA observed nowadays in adolescents from industrialized countries, may affect their longer-term health (Berger, 2007). As a consequence, the burden of morbidity and mortality for NCDs has risen worldwide among adolescents (Catalano et al., 2012), being mostly related to an increase in diabetes, overweight and obesity (Hsia et al., 2009; Ng et al., 2014). In UK, the prevalence of children receiving insulin and oral antidiabetic drugs has increased twofold and eightfold respectively between 1998 and 2005, especially among the 12 to 18 years old age group (Hsia et al., 2009). Data including 21 different European countries showed a tendency for a higher prevalence of overweight childhood and adolescents in Western and particularly Southern Europe; in Spain the percentage of overweight adolescents aged 14-17 reach

the 21% and together with Greece (22%) are the countries with higher overweight prevalence (Lobstein & Frelut, 2003). Furthermore, the proportion of children and adolescents from developed countries with BMI of 25 KG/m² or greater has increased by +6.9% in boys and +6.4% in girls between 1980 and 2013 (Ng et al., 2014). The increased prevalence of obesity among adolescents has been associated with the growing incidence of cardiovascular disease or type 2 diabetes in this period of life (Han, Lawlor, & Kimm, 2010).

As a result, NCDs has caused 1.3 million of adolescents´ deaths worldwide during 2012 (WHO, 2014). This could have been prevented by addressing the rapidly increase of negative behavioural risk factors among adolescents that has been observed during the last 10 years including lower PA levels, higher rates of tobacco use and binge drinking (Patton et al., 2012). In Spain, Non-communicable diseases caused 661.282 DALYs (84% of the total) in 2008. The main specific causes of disease burden were: depression (16% of DALYs), alcohol (11%), headaches (9%), bipolar disorder (7%), schizophrenia (6%), traffic accidents (5 %) and drug addiction (5%) (Català-López et al., 2013). In Catalonia, the mortality rate among adolescents and youth (14 to 29 years old) stands around 37 deaths per 100,000 young people every year, being the mortality rate higher for male (0.55%) than female (0.17%) (Elvira, 2010). Noteworthy, the main causes of death among this group of age are external and, therefore, preventable (traffic accident and suicide) (Bayon et al., 2009).

In this context, the Spanish government aimed to promote actions to achieve the maximum development of children and adolescents health, by promoting health related behaviours (Ministerio de Sanidad, Servicios Sociales e Igualdad, 2013b). Some of the main actions planned to achieve this goal are: to promote PA and healthy eating

in schools and at leisure time, to promote responsible use of alcohol among underage, to make students aware about the importance to have healthy habits (Ministerio de Sanidad, Servicios Sociales e Igualdad, 2013b). For its part Catalan current health aim to promote healthy lifestyles at all levels, encouraging the adoption of healthy lifestyles to counteract actual harmful lifestyle behaviours that have a high cost to public health (Torralba, 2014). Different programs targeting adolescents have been developed in Spain and Catalonia aiming to achieve these goals such as the NAOS strategy (Strategy for Nutrition, Physical Activity and the Prevention of obesity) promotes any initiatives that help to encourage children and young people to adopt healthy lifestyles, mainly through healthy diet and regular PA (Ministerio de Sanidad y Consumo, 2005). Interestingly, the scopes and areas of action and influence of the NAOS strategy are multiple: families, schools, the business world and the health system (Ministerio de Sanidad y Consumo, 2005). In Catalonia the main strategy to promote PA and healthy diet is called PAAS and similarly to the NAOS strategy it pretends to join forces and different strategies in order to develop a common action to promote PA and healthy diet in schools, the community, the business world and the health system (Generalitat de Catalunya, 2008).

In conclusion, it is essential to review adolescents' health-related behaviours as a preliminary step to develop formative research that assess policy makers and health promotion specialists in designing targeted interventions to improve adolescents´ health (Catalano et al., 2012).

Prevalence and importance of physical activity in adolescents

Current scientific consensus recommends that adolescents should participate in a wide range of enjoyable and safe physical activities that support their natural development (Tammelin, Näyhä, Hillas, & Järvelin, 2003). PA should preferably be aerobic although exercises that strengthen muscles and bones should be also included (WHO, 2010). Current PA recommendations for adolescents include accumulating 60 minutes of moderate to vigorous-intensity PA a day (WHO, 2010).

Cross-sectional and longitudinal data have identified associations between achieving PA recommendations in adolescence and (i) showing higher levels of cardiorespiratory fitness, muscular endurance and muscular strength, (ii) enhanced bone health, (iii) reduced body fat, (iv) lower blood pressure, (v) having a better cardiovascular and metabolic risk profile and, (vi) showing reduced symptoms of anxiety and depression (Janssen & Leblanc, 2010; Buchan et al., 2011).

In contrast, not achieving PA recommendations have been linked to the development of several chronic conditions during adolescence (Hallal, Victora, Azevedo, & Wells, 2006b; Colberg et al., 2010). A study with Spanish 2,859 adolescents (13 to 18.5 years old) reported that 19.3% of the boys and 17.3% of the girls who presented cardiovascular risk factors (threshold of VO^2Max=42 ml/kg/min for boys and 35 ml/kg/min for girls) showed the poorest scores on physical fitness (strength, aerobic capacity, speed and flexibility) (Ortega et al., 2005). Regular PA during adolescence has been also linked to improved blood glucose control, insulin action and the prevention of type 2 diabetes (Colberg et al., 2010). High volumes of daily vigorous PA

have been related to lower body fat (Lobstein & Frelut, 2003; Janssen et al., 2005); with adolescents engaging in >40 minutes of vigorous PA per day showing lower sum of 5 skinfold thickness (-3.5mm) compared to those engaging in 10–18 minutes of vigorous PA per day (Ruiz et al., 2006). Similarly, a systematic review showed negative associations between objectively measured PA and adiposity in 38 out of 48 of the studies reviewed (Jiménez-Pavon, Kelly, & Reilly, 2010).

Despite the health benefits related to achieving current PA recommendations, a high percentage of adolescents in industrialised countries are physically inactive (Hallal et al., 2012). A report with comparable estimates for physical inactivity in 13-15 years old from 105 countries worldwide showed that 80.3% of 13 to 15 years old did less than 60 minutes of daily MVPA (Hallal et al., 2012). While over 80% of boys were inactive in 56 countries; 80% of girls were inactive in 100 countries out of the 105 included in the study (Hallal et al., 2012). Previous research has shown significant differences in PA levels between boys and girls (Ruiz et al., 2011; Roman et al., 2006; Gordon Larssen et al., 2004; Aarnio, Winter, Peltonen, Kujala, & Kaprio, 2003), indicating the need to investigate the several aspects related to PA behaviour by gender (Aarnio et al., 2003). In European adolescents, the prevalence of physical inactivity also remains high (Ruiz et al., 2011; Verloigne et al., 2012). A survey conducted in 9 European countries (n=2,200) with adolescents between 12.5 to 17 years old indicated that 43.2% of boys and 72.5% of girls failed to meet the PA recommendations (Ruiz et al., 2011). Similarly, using objective data of PA in adolescents from 5 different countries (n=686) showed that only 16.8% of the boys and 4.6% of the girls met MVPA recommendations (Verloigne et al., 2012).

In Spain, a survey conducted with 1,357 boys and 1,502 girls between 13-18.5 years of age reported that 28.9% of the boys and 53.3% of the girls were physically inactive (Tercedor et al., 2007). When using objective measures of PA (accelerometry), a survey (n=385; 189 boys) showed that 77.5% of the girls and 45% of the boys failed to achieve the 60 min/day of MVPA (Gracia-Marco et al., 2011). In Catalonia, 15% of Catalan adolescent girls and 9% of the Catalan adolescent boys are slightly active (doing 20 minutes of MVPA during free time at least once a week), with 13% of the boys and 26% of the girls not doing any PA during leisure time (Secretaria de Joventut, 2010). More recent results indicate that 20.9% of Catalan children and early adolescents have not participated or rarely participate in MVPA at leisure during last month (Departament de Salut, 2015).

In summary, physical inactivity is a highly prevalent behaviour among adolescents in modern societies that negatively affects their health and contributes towards the development of NCDs. Physical inactivity is a major contemporary health issue that needs to be addressed in early phases of life in order to prevent and control the development of chronic diseases as adults. Objectives to be achieved in the Health Plans among teenagers include the reduction of physical inactivity and to make adolescents aware about the importance to achieve the PA recommendations for health (Ministerio de Sanidad, servicios sociales e igualdad, 2015) with the following set of actions proposed to attain the goal: (i) Four million school children will benefit from new educational materials aimed at increasing PA in the classroom. (ii) The schools from Spain will promote active breaks between classes (Ministerio de Sanidad, servicios sociales e igualdad, 2015).

Prevalence and problems related to smoking behaviour in adolescents

Adolescence is a particularly vulnerable period for developing substance abuse behaviours (Winters & Lee, 2008) such as tobacco consumption. The main reasons why adolescents start smoking (either experimental or temporary) are primarily related to the influence of the immediate social environment (best friend tobacco consumption (OR=7.44); cigarette availability at home (OR=1.49) and the use of other drugs (use of alcohol (OR=11.82); use of marijuana (OR=1.68)) (Caballero-Hidalgo, Gonzalez, Pinilla & Barber, 2006; Park, Weaver & Romer, 2009). It is well known that smoking negatively affects youth´ health by causing detrimental changes in their lung function, increasing the risk of new-onset asthma (Gilliland et al., 2006; Gan, Man, Postma, Camp & Sin, 2006), increasing their levels of triglyceride, and LDL cholesterol and lowering their levels of HDL cholesterol (Reynolds et al., 2011) and causing harmful effects in the adolescents´ mental health such as stress (Falkin, Freyer & Mahadeo, 2007). Furthermore, smoking hurts young people's physical fitness in terms of performance and endurance (CDC, 1994), with their resting heart rates being two to three beats per minute faster than non-smokers (CDC, 1994) with teenage smokers suffering from shortness of breath almost three times as often as teens who don't smoke, and with smokers producing phlegm more than twice as often as teens who don't smoke (Arday, 1995).

Although smoking levels has sharply decreased worldwide since 2000 from 25% to 17% (OECD, 2013), the percentage of adolescent smokers remains high. In Europe, 58% of students between 15 and 16 years old smoked cigarettes at least once in their life and,

29% had smoked cigarettes during the past 30 days (Hibell et al., 2009). In Spain, 23.3% of the adolescents are current smokers, showing an increased prevalence across adolescence. While 5% reported smoking at age 14, this percentage peaks to 28% when they are 17 to 18.5 years old. Similar patterns have been identified across genders (Tercedor et al., 2007; Secretaria de Joventut, 2010). In Catalonia, 45% of the Catalan students affirmed they have smoked at some time in their life, 37% have smoked over the past 12 months, 28% smoked in the last 30 days and 13% smoked daily in 2012. Furthermore, every year 1,200 teenagers (14 years old) start smoking in Catalonia (Departament de Salut, 2013). Thus, one of the main aims of the Catalan government is to reduce the incidence of daily consumption of tobacco (13%) among adolescents (14-18 years) (Agència de salut pública de Catalunya, 2013).

With evidence indicating an early initiation and subsequent continuation of smoking behaviour throughout adolescence (Kelder, 1994; Paavola, 2004), on-going efforts in public health should focus not only on reducing the prevalence of smokers across adolescence but also on preventing the adoption of this harmful behaviour at this early stage in life (WHO, 2013).

Prevalence and problems related to alcohol consumption in adolescents

Alcohol consumption is the main modifiable risk factor causing disability-adjusted life years in young people from 10 to 14 years of age contributing towards 7% of the total years lost worldwide (Marshall, 2014). Evidence suggests that alcohol use in youth (i) increases the risk of both fatal and nonfatal injuries (Hingson, Heeren, Winter, & Wechsler, 2005), (ii) is associated with developing mental health problems (i.e. suicide, depressive and anxiety disorders) as well as social harms (i.e. antisocial behaviour) (McCambridge et al., 2011), (iii) it increases risk of cardiovascular diseases, respiratory illnesses and cancer (Currie, 2012) and, (iv) increases risk of developing alcohol dependence at some point in life when harmful use of alcohol starts before 15 years of age (Marshall, 2014). Moreover, adolescents who indulge in drinking are more likely to engage in risky behaviours, such as drinking and driving (Hingson et al., 2005). Besides all this health related problem, alcohol consumption is not allowed among under 18 years of age (Ministerio de Sanidad, Servicios Sociales e Igualdad, 2015), which corroborates that alcohol consumption among this age group should be non-existing.

Despite the detrimental health effects of alcohol consumption, drinking alcohol is highly prevalent in adolescents from developed countries especially during weekends (Steketee et al., 2013; Ruiz-Juan & Ruiz-Risueño, 2010). Drinking and drunkenness remains higher among boys than girls (+4.8%) in the majority of developed countries (Simons et al., 2009). The European School Survey Project on Alcohol and Other Drugs showed that 61% of students (aged 15 to 16 years old) from 35 countries had drunk alcohol at least once in the previous 30 days. However, regular alcohol drinking

(drinking in 10 occasions or more during the last month) was not reported as a common pattern (Hibell et al., 2009).

Alcohol consumption increases through adolescence with a Spanish study reporting an increase of habitual alcohol consumption during the weekends from 26% to 56.8% in secondary and high school respectively (Ruiz-Juan & Ruiz-Risueño, 2010). In Spain the prevalence of adolescents who has consumed alcohol during the last month is just under 20% (18%) (Steketee et al., 2013). In Catalonia, adolescents start drinking at a mean age of 16.5 years old, showing that 67% of adolescents drank alcohol during the last month (Secretaria de Joventut, 2010). Recent surveys from Catalonia have found a high prevalence of risk alcohol consumers (≥28 units/week for boys and ≥17units/week for girls) among adolescents and youth (15 to 24 years old) (10.1%; 13.8% of boys) (Departament de Salut, 2015).

In this context, the main aims from the Catalan government consist in increasing the mean starting age of alcohol drinking (>16.5 years old), and reduce the prevalence of youth risk consumers (<10%) (Agència de Salut Pública de Catalunya, 2013). Different strategies have been implemented in the recent years to accomplish these aims such as the PAPD (Agència de Salut Pública de Catalunya, 2013) that aims to fight the high prevalence of substance use in Catalonia.

Prevalence and problems related to low fruit and vegetable intake in adolescents

A insufficient daily fibre consumption (less than 400 grams/day) has been related to (i) an increase rate of obesity among adolescents (Warnberg, Ruiz, Ortega, Romero, & Moreno, 2006), (ii) a worse self-rated health (Takaoka, 2013) (iii) a worse bone mineral status, especially at the spine and femoral neck (Prynne et al., 2006) and, (iv) a reduced risk of coronary heart disease due to fruit and vegetable intake helping to lower blood pressure and modulate cholesterol (He et al., 2007; Hartley et al., 2013). Furthermore, evidence suggests that dietary patterns established during childhood are predictive of patterns later in life (Lien et al., 2001). A systematic review identified that main determinants of fruit and vegetable consumption among children and adolescents are parental food consumption patterns, preferences of the adolescent, socioeconomic position and availability of fruits and vegetables at home (Rasmussen et al., 2006).

Although the several benefits related to fruit and vegetable intake, the percentage of adolescents in industrialized countries achieving the fruits and vegetables recommendation for health (5 daily servings; EUFIC, 2012) remains low in industrialized countries. A longitudinal study found out that only 35% of Canadian adolescents consumed 5 pieces of fruits and vegetables per day (Takaoka & Kawakami, 2013). In Europe, the HELENA study (n=3,528 adolescents) showed that European adolescents eat half of the recommended amount of fruits and vegetables (n=2.5) (Moreno et al., 2014). In Spain, the group of late adolescents and early adults (15-24 years old) who daily consume fruits and vegetables is 41.8% (43.9% of girls) and 32.7%

(36.8% of females) respectively (INE, 2014). Similarly, a sample of 1.095 adolescents from Andalusia reported that only 42% and 12.1% eat fruit and vegetables every day respectively (Paniagua et al., 2014). In Catalonia, only 7.7% (9% of boys) of children and adolescents (0-14 years old) achieve the fruit and vegetable guidelines of 5 daily servings (Departament de Salut, 2015).

With longitudinal evidence indicating a secular decline in fruits and vegetables intake through adolescence (Larson, Neumark-Sztainer, Hannan, & Story, 2007) showing no differences between genders (Lowry et al., 2009); encouraging fruit and vegetables consumption across adolescence is a key issue in the prevention of development of NCDs as it is stated in the Public Health strategies (NAOS, 5 al dia) where main objectives are set to achieve the daily serving of fruit and vegetable intake during adolescence (Ministerio de Sanidad y Consumo, 2005; Secretaria de Salut Pública, 2013).

Prevalence and problems associated to sedentary behaviour in adolescents

Spending too much time sitting during adolescence has been related to an increase of the incidence in metabolic syndrome in both genders; raising from 3.7% to 8.4% when spending 1 hour/day or 5 hours/day sitting in front of a screen respectively (Mark & Janssen, 2008). In Australia, overall sitting time (more than 425 minutes/day) and TV viewing time (more than 150 minutes/day) has been associated with worse cardio-metabolic risk biomarkers (Thorp et al., 2009). In Spain, viewing TV for more than 3 hours/day (n=425; 13-18.5 years; 53% sitting>3 hours/day) has been linked to

unfavourable values of HDL-cholesterol, glucose and CVD score (Martinez-Gómez et al., 2010). Moreover reducing sitting time may promote social abilities, improve process of learning and attention, and increase the self-esteem of adolescents (Ministerio de Sanidad, Servicios Sociales e Igualdad, 2015b).

Despite the harmful effects of spending too much time sitting, objective measurements (accelerometry) of sedentary time from 2,200 European adolescents aged 12.5 to 17.5 years identified that 70% of the sample spent most of their waking time on sedentary behaviours (Ruiz et al., 2011). In a female sample (n = 111) that provided objective measurements from inclinometers (ActivPal) an average of 18.8 and 18.9 hours were spent sitting or lying down over 48 hours (24 hours on a weekday and 24 hours on a weekend day respectively); indicating that female adolescents were sedentary over 66% of the time within a period of 24 hours (Harrington, Dowd, Bourke & Donnelly, 2011). In 5 different European countries, the mean sedentary time spent among the sample (n = 686; mean age = 11.6 years old) across countries was 487 min/day (8.11 hours/day); with girls spending more time sedentary (8.33 hours/day) than boys (7.9 hours/day) (Verloigne et al., 2012).

Time spent sitting in front of a screen at leisure time, including television viewing and internet use for non-study reasons, is the most popular sitting activity at leisure among adolescents due to easy accessibility (Rey-López et al., 2010). In California, adolescents aged 12-17 years old (n=4029) sat an average of 1.36 hours/day and 1.61 hours/day on weekdays and weekends respectively in front of computers (Shi & Mao, 2010).

In Europe, 35% of adolescents (≥15 years old) exceeds the American Academy of Pediatrics recommendations for non-educational screen time (≤2h/day) during week days, and 56% exceeded it during weekends (Rey-Lopez et al., 2010). Eighteen percent

and 32% of European adolescents spent more than two hours/day using internet for non-study reasons on weekdays and weekends respectively (Rey-López et al., 2010); with Spanish adolescents (n=3,503; aged 12-18 years old) showing that 15.1% spent more than two hours a day in front of a computer (Serrano-Sánchez et al., 2011).

When combining TV viewing and computer use (total screen time; TST), the percentage of Spanish adolescents that spend more than two hours a day in TST raises to 66.6% (Serrano-Sánchez, 2011). TST is specially high in Catalonia where 15 to 16 and 17 to 18 years old adolescents sit in front of a screen an average of 3.33 hours/day and 2.5 hours/day during weekdays and 4.9 hours/day and 3.5 hours/day during weekends (computer, TV and videogames) respectively; with boys reporting higher TST than in girls (+70 minutes/day; Nebot et al., 2010). Although evidence reports mixed-results, it seems that time spent sitting at leisure time in front of computer seems to increase across adolescence (Nelson, Neumark-stzainer, Hannan, Sirard, & Story, 2006b; Brodersen, Steptoe, Boniface, & Wardle, 2007; Nebot et al., 2010). However, more longitudinal research is needed before further conclusions can be drawn.

In summary, high volumes of daily sitting, including screen time, is associated with the development of several NCDs during adolescence, including unfavourable CVD risk factors profiles. In Spain general guidelines from the National Health Plan explain that youth should minimize they sedentary time by (*i*) limiting recreational screen time to no more than 2 h per day; and (*ii*) limiting sedentary (motorized) transport, extended sitting time, and time spent indoors throughout the day (Ministerio de Sanidad, Servicios Sociales e Igualdad, 2015b; Tremblay et al., 2011).

Summary of key issues

- Currently, NCDs are important causes of adolescents' morbidity and mortality. Risk factors for NCDs are spreading rapidly during the last years in this age group. This is related to unhealthy behaviours such as low PA levels.
- The high prevalence of teenagers not meeting the PA recommendations (80.3%) is a major contemporary health issue. This prevalence varies across gender.
- In Spain, 23.3% of the adolescents are usual cigarette smokers and the number of smokers increases through adolescence.
- Alcohol consumption is habitual among adolescents. Early alcohol drinking increases risk of developing alcohol dependence at some point in life.
- European adolescents eat half of the recommended amount of fruits and vegetables.
- European adolescents spend 70% their waking time in sedentary behaviours, being screen time prevalent among them.
- National Health Plans aim to reduce NCDs by improving lifestyle behaviours (increasing PA levels, reducing tobacco and alcohol intake, increasing fruit and vegetable daily servings, decreasing sedentary behaviour) of Spanish adolescents.

Changes in lifestyles from adolescence to adulthood: Influence on adults' health.

Individuals experience several transition points across the lifespan (i.e. from childhood into adolescence, from late adolescence into early adulthood, the start of the work life and the beginning of retirement) that concern the adoption and maintenance of lifestyle behaviours (Roman et al., 2006; Hirvensalo & Lintunen, 2011; Telama, 2009).

The transition point from adolescence into young adulthood is a life developmental period that involves an extended duration of learning and experimentation before settling into a career and a stable personal relationship (Sussman & Arnett, 2014). As part of this process, several changes occur in adolescents´ life such as deciding whether to enrol on undergraduate degrees at University or engage in professional training for manufacturing companies (Ministerio de Educacion, Cultura y Deporte, 2013b; Observatori Sistema Universitari, 2015). In Spain, the percentage of adolescents enrolling University degrees has substantially increased during the last decade; showing an increase of 13.7% since the 2007-2008 academic year (Ministerio de Educacion, Cultura y Deporte, 2013b). Currently, the net enrolment rate for Spanish universities is 28.6% of the young population predicting a growing trend for the next years related to the perception of having a better chance to attain youth´s professional goals (Ministerio de Educacion, Cultura y Deporte, 2013b).

Taking into account that health-related behaviours are often established during childhood and adolescence (Kann et al., 2011) and that a wide percentage of Spanish adolescents go to University (Ministerio de Educacion, Cultura y Deporte, 2013b), it is

important to examine not only how health-related behaviours from adolescence track into adulthood (Buchmann, 2013) but also how this occurs on the transition from high school into University. This will allow understanding how lifestyle patterns adopted during adolescence can influence the adoption of healthy lifestyles during adulthood (Kann et al, 2011), specially on those going to University. To observe tracking, longitudinal data for at least two points in time within that period are necessary (Telama, 2009).

Tracking of PA from adolescence to adulthood

During the transition point from late adolescence (14-17 years old) to early adulthood (18-22 years old), PA levels can observe sustainable changes and significantly decrease or increase as other sedentary behaviours compete for this free time such as hanging out with friends, doing homework or using the computer (Boreham et al., 2004; Olds et al., 2009). Research emphasises the importance to study and intervene during the period of transition from adolescence to adulthood to avoid PA decrease and to prevent metabolic syndromes as adults (Ferreira et al., 2005).

Although a reasonable amount of studies have tracked PA from adolescence into adulthood, available evidence is not conclusive about how MVPA tracks from adolescence to adulthood, neither in which gender these behaviours track better (Boreham, Robson, Gallagher, & Cran, 2004; Azevedo, Araújo, Cozzensa, & Hallal, 2007; Cleland, Dwyer, & Venn, 2012).

A study conducted in Australia with 2201 participants followed from 9-15 years to 26-36 years found that childhood and adulthood activity were weakly correlated (r=-0.08-0.14); although the tracking of PA varied by domains such as leisure activity in childhood which predicted adult leisure activity among males (Cleland et al., 2012). Another study conducted in Brazil found that subjects who were physically active during adolescence were more likely to be physically active in adulthood (r=1.42). Interestingly, the effect of adolescent PA on the level of activity during adult life was higher in women than men (r=1.51 for women and 1.35 for men) (Azevedo et al., 2007). In another study, six hundred and forty Canadian adolescents were first surveyed at age 12–15 years, and were then interviewed biannually until they were 24–27 years old. Fındings indicated a general decline in PA although the rate at which PA declined was steeper for men (30% decrease or 1.54 METs/day) than for women (17% decrease or 0.59 METs/day) (Kwan, Cairney, Faulkner, & Pullenayegum, 2012). Some data illustrates the differences on tracking PA between genders.

In Norway, a National-based study followed up a group of 2,348 children from middle adolescence (13 years old) to early adulthood (19 years old). Among the entire sample, the percentage of participants who were active and became inactive at follow up was 18% for boys and 15% for girls (Rangul et al. 2011). In Ireland, one study assessed 245 boys and 231 girls at age 15 and again at age 22 using questionnaires; the study identified poor tracking in females (*k*.0.021) and only moderate levels of tracking in males (*k*.0.202*)* for PA scores (Boreham et al. 2004). In Spain, the amount of minutes/day that people practice MVPA increases until 13 years old (43.8min/day) but reduces drastically between 14 and 17 years old (42.6 minutes/day) and less drastically between 18 and 24 years old (30.6 minutes/day) (Roman et al. 2006).

In the literature we could find two main explanations regarding this decline in PA during this transition point. First, during adolescence PA is organized and school-based while early adulthood PA is likely to be more a matter of choice and potentially require more motivation because of a need to self-direct (Boreham et al., 2004). Therefore, changing from structured sporting activities to unstructured PA during this transition point may negatively influence PA levels (Eime, Payne, Casey, & Harvey, 2010). Second, the substantial environmental and social changes encountered in the daily life of the adolescents during this age period might produce a decline in their PA levels (Craggs et al., 2011).

Because the majority of the studies remark a steeper decline in PA during the transition from adolescents to adulthood (Roman et al., 2006), it may be suggested that high levels of PA across childhood and adolescence may predict adult PA (Telama, Yang, Hirvensalo, & Raitakari 2006). This indicates that helping out youth to engage in regular PA, and achieve the minimum recommendations across childhood and adolescence (60 minutes of moderate to vigorous-intensity PA daily) (WHO, 2010), is a key component to improve the adult´s population´s health, quality of life and reduce the social, economic and environmental impact of the physical inactivity burden. This period of time seems to be of great importance for the good tracking of PA through the lifespan.

Tracking of PA from adolescence to adulthood in first-year university students

First-year university students have reported to gain weight at the start of University life due to the adoption of an unhealthy diet, high stress levels, and decreased exercise (Molina-García et al., 2015). Although a recent study indicated that undergraduate students only gained an additional half-pound compared to the same-age group who did not attend to university (Zagorsky & Smith, 2011); it is important to highlight that among university students who gained ≥5% of body weight, 60.7% reported engaging in less PA than high school (Wengreen & Moncur, 2009).

In Spain, a sample of high school students from Valencia followed-up during one year (n=244; 58.6 females), reported a decrease in leisure-time PA in both genders (-35% in males, -43% in females); showing a drop of the follow up rate to 46% (Molina-García et al., 2015). In Canada, a group of 145 students completed retrospective measures assessing vigorous PA during their first 2 months at university and their last 2 months at high school; indicating that while 66.2% of students reported adequate levels of vigorous activity in high school, only 44.1% met the recommendation during their first 8 weeks at university. Finally, a longitudinal study with 291 Flemish students followed up from high school to university concluded that changes in residency and psychosocial factors (such as decreases in self-efficacy, competition-related benefits, and increases in health- and time-related barriers) were key factors in explaining the decrease in leisure-time MVPA over this transition period (adjusted R^2 = 29.3 %) (Van Dyck et al., 2014).

Because university students reduce their PA levels during University life (Dias Fontes & Pinheiro, 2009), confirming the decline of PA in adolescents that go from high school to university (Nelson, Gortmaker, Subramanian, & Wechsler, 2007) and; because undergraduate students that become insufficiently active show higher levels of fatigue and lower levels of vigour (Bray & Born, 2004); it is important to focus ongoing efforts on this population group to avoid PA declines and prevent the physical inactivity-related burden of disease in the early adulthood.

Tracking of smoking behaviour from adolescence to adulthood

Evidence suggests that tobacco consumption is a harmful behaviour that tracks from adolescence into adulthood (Buchman et al., 2013; Paavola et al., 2004). A national-based study indicated that 52% of Argentinian adults started smoking between 12 and 17 years of age, while 30% started between ages 18 and 20 years old (Borracci & Mulassi, 2014). In the United States, 9 out of 10 smokers first smoked cigarettes before age 18 (CDC, 2011) and a Finnish longitudinal study (n=900) identified that smoking at 28 years of age was correlated with an early start at 15 years old (r=.42) (Paavola et al., 2004). A recent mixed-method study (Buchmann, 2013) indicated that adolescents who started smoking at an earlier age had an increased pleasurable sensation of smoking which was linked to being a regular smoker at age 22 (Buchmann, 2013).

In addition, regular smoking during adolescence has been identified as a predictor for later substance-use related problems in young adulthood (i.e. alcohol use, marihuana)

(Riala et al., 2004, Moss, Chen, Yi, 2014). It is important to highlight that eliminating tobacco use during adolescence could reduce the tobacco consumption rate during adulthood by 12.2-16.2% (Borracci & Mulassi, 2014).

Tracking of alcohol consumption from adolescence to adulthood

Research has shown that youth who use alcohol before age 15 are five times more likely to become alcohol dependent than adults who begin drinking at age 21 (Office of Applied Studies, 2004).

A systematic review including 54 studies found consistent evidence that higher alcohol consumption in late adolescence continues into adulthood and is also associated with alcohol problems including dependence (McCambridge et al., 2011). Another study that summarized results of recent epidemiological research indicate that alcohol consumption in late adolescence appears to persist into adulthood and is associated with alcohol problems (Marshall, 2014). As confirmed with these literature reviews the findings are consistent in indicating the good tracking of alcohol consumption from adolescence to adulthood. However, based on the literature, there are some factors that may influence this tracking of alcohol consumption.

Firstly, Mrug & Windle (2014) stand out the importance of friends' alcohol use during adolescence (age 17) as an important factor predicting greater alcohol use and more frequent heavy drinking at early adulthood (age 23). Secondly, gender affects tracking of alcohol consumption from adolescence to adulthood. A recent longitudinal study

with more than 1000 participants found that women who drank alcohol at greater amounts at age 16 were more likely to drink at a higher level at age 43. On the other hand, no relationship was found between male consumption at age 16 and age 43 (Delfaboro & Hammarström, *2014).* Another longitudinal study found similar results because the strongest adolescent predictors of excessive alcohol use in adult females were drunkenness-orientated drinking (Huurre et al., 2010).

Tracking of fruit and vegetable intake from adolescence to adulthood

Current research indicates a low-to-moderate tracking of fruit and vegetables consumption from adolescence into adulthood; indicating a decline in fruits and vegetables consumption during this transition point (Lake, Mathers, Rugg-Gunn & Adamson, 2006; Velde, Twisk, & Burg, 2007; Lien, Leslie, & Klepp, 2001). However, longitudinal studies tracking dietary intake of Europeans is scarce (Craigie, Lake, Kelly, Adamson, & Mathers, 2011).

In a sample of 198 participants from the United Kingdom, the tracking coefficient for fruit and vegetable consumption was 0.33 and 0.27 from 12 to 36 years old respectively (Lake, Mathers, Rugg-Gunn & Adamson, 2006). In a Norwegian sample (n=885), fruits and vegetables consumption decreased by 1-2.5 times per week between ages 14 and 21 (Lien, Leslie, & Klepp, 2001), while in Sweden the median daily fruit consumption decreased from 0.9 portions at age 17 to 0.4 portions at age 21 (Von Post-Skagegård et al., 2002). The percentage of Swedish youth who consumed vegetables after a single 24 hours recall also decreased from 79% at 15 years old to

70% at 21 years old (Pattersson, Warnberg, Kearney, & Sjöström, 2009). No longitudinal studies for fruit and vegetable tracking were found for the Spanish and Catalan population.

Since high fruits and vegetables consumption in adolescents has shown to have a beneficial influence on self-rated health in the early adulthood (Takaoka & Kawakami, 2013), it is important to start promoting fruits and vegetables intake at an early age and especially at the beginning of adulthood (Velde et al., 2007).

Tracking of sedentary behaviour from adolescence to adulthood

Evidence suggests that sedentary behaviour moderately tracks from adolescence to young adulthood; specifically sedentary time spent in front of a screen (Grøntved et al., 2014) and sedentary transport (Chillon et al., 2009). In Belgium, adolescent boys who exceed the screen time guidelines (≥ 2 hours a day) were three to five times more likely to exceed this guideline when they reached adulthood (Busschaert et al., 2015). Although evidence suggests a tendency to slightly reduce time spent sitting in front of a screen from adolescence to adulthood (Aires et al., 2010), the tracking of screen time and its negative health-effects from adolescence to early adulthood seems to persist. Thus, prolonged screen time during adolescence has been associated with unfavourable cardiovascular risk factors in young adulthood (Grøntved et al., 2014).

Evidence also indicates an increase of time spent in sedentary transport from adolescence into early adulthood (Coll et al., 2013; Chillon et al., 2011) including Spain (Chillon et al., 2009), resulting in mean decrease of active commuting of 8% of late adolescents. A Finnish longitudinal study (n=2,072) indicated that the proportion of active commuters at 12 years old was over 75% while it was reduced below 40% at age 40; with boys showing a sharper decline than girls (from 45% to 35%; Yang et al., 2014).

Since a consistent relationship has been identified between self-reported sedentary behaviour, mortality and weight gain from childhood to the adult years (Thorp, Owen, Neuhaus, & Dunstan, 2011); with similar findings indicating that efforts to decrease obesity among adults should consider reducing sedentary time spent watching TV among adolescents (Mamun, O'Callaghan, Williams, & Najman, 2013), it is important to highlight that reducing sedentary time during adolescence could reduce total sitting time during adulthood (Busschaert et al., 2015).

Summary of key issues

- Priority health-risk behaviours often are established during adolescence and extend into adulthood.
- Nearly 9 out of 10 smokers first tried cigarettes by age 18.
- Higher alcohol consumption in late adolescence continues into adulthood. This tracking may be affected for some factors such as gender or sport participation.
- There is a decrease of fruit and vegetable consumption from adolescence to early adulthood.
- Screen time tracks from adolescents to adulthood. Active commuting tends to reduce during this time.
- Although not conclusive, studies indicate that high levels of PA during adolescence may predict adult PA. The transition point from adolescence to early adulthood and, specifically, the switch from high school to university needs especial attention to avoid decline in PA levels.
- In this context, it is important to carry out descriptive research to help preventing the adoption of unhealthy lifestyles during adolescence as a way to diminish the prevalence of unhealthy behaviours during adulthood.

Cross-sectional and longitudinal associations between PA and other lifestyles in adolescence and early adults

Engaging in a greater number of unhealthy lifestyle behaviours (2 to 7 unhealthy lifestyle behaviours; i.e. smoking consumption, alcohol consumption, low fruit and vegetable intake or low levels of PA) has been associated with a higher prevalence of poor health-related quality of life (Duncan et al., 2014). Thus, adherence to one unhealthy lifestyle can lead to the adoption of other unhealthy lifestyle factors, resulting in a multiple risk behaviour pattern (MacArthur et al., 2012). For example, adolescents who spend larger amounts of time on sedentary behaviours are more likely to present unhealthy dietary patterns (Santaliestra-Pasías et al., 2014). Similarly, inactive teenagers show a higher prevalence of smokers than their active counterparts (Tercedor et al., 2007).

This section will present a review of cross-sectional and longitudinal data to examine (i) how the adoption of one health-related behaviour during adolescence relate to the adoption of other health-related behaviours and, (ii) how the adoption of health-related behaviours during adolescence relates to the adoption of other health-related behaviours during young adulthood. Focus will take place on how PA patterns relate to other health-related behaviours both cross-sectional and longitudinally since PA is the main selected variable for the present thesis and because the evidence is conclusive about the significant decline observed in PA from high school to university (Molina-García et al., 2015; Dias Fontes & Pinheiro, 2009; Nelson et al., 2007). The bibliographic table of the studies can be found in the appendices (appendix 1).

Database used, key words, custom date range and articles reviewed.

The research was conducted using three main databases: Pubmed, Scopus and Scholar google. The research was limited by date (custom date range 01/01/2000-31/12/2015) and country (only articles from developed countries were selected to be consistent with the present research).

In pubmed the specific words “Adolescent physical activity + substance use” were introduced, and 140 different articles appeared for this first search. In Scopus, the words “adolescents physical activity” and “substance use”, found a total of 484 articles. Furthermore the words: “associations between physical activity and cigarette consumption + adolescents”, with 394 results appearing in pubmed and 922 in scopus; “associations between physical activity and alcohol consumption + adolescents + early adults”, 3136 results in pubmed and 4247 in scopus. “Fruit vegetable consumption + adolescents” produced 16.800 results in google scholar, 1153 in pubmed and 1653 in scopus. “Adolescents physical activity + sedentary behaviour” encountered 1441 different articles in pubmed and 17.500 in google scholar. In Scopus, the words “adolescents physical activity” and “sedentary behaviour” were introduced; a total of 1449 articles were found in this database. Another set of words were used for sedentary behaviour: screen time + physical activity + youth. In this case, 17.100 results appeared in google scholar, 364 in pubmed and 370 in scopus.

Seven cross-sectional studies and 4 longitudinal studies were selected finding associations between PA and cigarette consumption. Four cross-sectional and zero

longitudinal studies conducted in Spain. Seven cross-sectional studies and 2 longitudinal found associations between PA and alcohol consumption. One cross-sectional study and zero longitudinal studies conducted in Spain. Six cross-sectional studies and 1 longitudinal study found associations between PA and fruit and vegetable intake. No Spanish studies for this association. Seven cross-sectional studies and 4 longitudinal found associations between PA and sedentary behaviours. One cross-sectional study and zero longitudinal studies from Spain.

Associations between tobacco consumption and PA

Cross-sectional studies

A systematic review indicated that 60% of the 50 article reviewed reported a clear negative association between tobacco consumption and PA (Kaczynski, Manske, Mannell, & Grewal, 2008). Indeed, worldwide cross-sectional studies agree about the protective role of PA on cigarette consumption (Delisle, Werch, Wong, Bian, & Weiler, 2010; Aarnio et al., 2003). A study with 822 students from Florida (USA), identified that high level of vigorous PA (≥ 5 times a week) was significantly associated with less frequent cigarettes use ($F = 3.59$ $p = .03$) (Delisle et al., 2010). In Finland a study found that the percentage of regular smokers at the age of 16 in the very active group was 12.6% and in the inactive group was 45.6% (Aarnio et al., 2003). Moreover, the proportion of adolescent students with low PA and tobacco smoking seem to increase with increasing age due to the association between these behaviours become stronger

as adolescents get older (OR=1.47 (17-18years old) and OR=1.88 (18-19 years old) (Haug et al., 2013).

Three different studies conducted in Spain found that inactive or low active adolescents and early adults are more prevalent smokers than their regular active colleagues (Tercedor et al., 2007; Moreno at el., 2012; García, Villalba, Miñarro, & Cantó, 2014). A study conducted over 2.859 Spanish adolescents aged 13-18.5 years, found inactive teenagers to be more prevalent smokers than the active ones (29% Vs 19%) (Tercedor et al., 2007). A higher level of PA (physical exercise > 1 times a week) among 344 Spanish (aged 14-17 years) was positively associated with non-consumption of tobacco for boys (p .05) and girls (p .001) compared to inactive adolescents (García, Villalba, Miñarro, & Cantó, 2014). In Spain a significant relationship between leisure time PA and smoking (OR = 7.373) was found; because an inactive lifestyle was prevalent among smokers (51.9%) but not among non-smokers (40.5%) (Romo et al., 2010). Finally, a cross-sectional study conducted over 987 university students from the Balearic islands (Spain) demonstrated that non-smoking was associated with being physically active (Moreno et al., 2012). All the studies reviewed found that PA was independent protective factors for smoking behaviour (Dunn, 2014).

Longitudinal studies

Longitudinal studies show negative associations between PA and smoking during late adolescence and early adulthood (Paavola et al., 2004; Aarnio et al., 2003). Aarnio et al. (2003) found that the percentage of regular smokers at the age of 16 in the very

active group was 12.6% and in the inactive group was 45.6%. Furthermore, after a three-year follow-up, non-smoking was significantly associated with persistent exercisers and smoking with persistent inactivity among both boys and girls. Another longitudinal study from Finland which followed 903 subjects from 15 to 28 years old, found a negative association between PA and smoking at each study point (Paavola et al., 2004). Indeed, adolescents with decreasing PA levels are important groups to target for tobacco use prevention and intervention efforts (Audrain-Mcgovern et al., 2012). It is similarly notorious that smoking tobacco in adolescence (12 to 19 years) predicted low levels of leisure time PA 13 years later (Wichstrøm, von Soest, & Kvalem, 2013). No Spanish or Catalan studies were found investigating longitudinal associations between PA and cigarette use during this transition point.

Associations between alcohol consumption and PA

Cross-Sectional studies

Two cross-sectional studies indicate no strong association between high levels of PA and low levels of alcohol consumption during late adolescence and early adulthood (Moreno et al., 2012; Delisle et al., 2010; Moore & Werch, 2005). One study found a negative association between alcohol consumption and PA Contrarily (Ruiz-Juan, & Ruiz-Risueño, 2007). However, the several studies reviewed (n=3) indicated that engaging in higher levels of PA was associated with higher levels of alcohol

consumption (VanKim, Laska, Ehlinger, Lust, & Story, 2010; Musselman & Rutledge, 2010).

Two studies (one from Spain) found no significant associations between PA and alcohol consumption. Firstly, a Spanish study found similar alcohol consumption patterns between adolescents doing some PA than physically inactive inactive adolescents (80.3 Vs 79.7 respectively; OR = 1.00) (Moreno et al., 2012). Secondly, the differences regarding alcohol consumption between adolescents (mean age = 17 years) reporting 0–1 times of MVPA in the past 7 days (n=271) and those reporting 5 or more times of MVPA (n=220) were non-significant (p = .47) (Delisle et al., 2010). One Spanish study found a negative association between alcohol consumption and PA. The highest percentages among alcohol abstainers were amongst active adolescents (10% more than inactive). Similarly, the highest amount of habitual drinkers were seen among those who claim to be inactive (differences ranging between 4% and 10%) (Ruiz-Juan, & Ruiz-Risueño, 2007). Finally, 3 cross-sectional studies found positive associations between these two variables: American college students (n=9.931) who engaged in higher levels of moderate PA were 29% more likely to be heavy drinkers (≥ 3 drinks a day for males and ≥ 2 drinks a day for females) versus abstainers (do not drink alcohol) (Adjusted Relative Risk (ARR) = 1.29). Similarly, vigorous PA (ARR: 1.44) were associated with increased risk of heavy drinking compared to abstaining (Vankim et al., 2010). Data from 296 male and females college students demonstrated that the odds of being in a higher PA category increased with higher levels of alcohol consumption (OR = 1.32 for alcohol frequency). For each unit of increase in alcohol consumption,

there was a 32 percent increase in the odds of being in a higher physical activity category (Musselman & Rutledge, 2010).

Although the results are not conclusive, some cross-sectional studies report a positive association between alcohol consumption and PA in adolescents (Musselman & Rutledge, 2010; Higgins et al., 2003). However, the lack of recent systematic reviews makes difficult to draw final conclusions.

Longitudinal Studies

Despite a good amount of studies longitudinally assessing alcohol consumption and sport participation, only two studies examinated longitudinal associations between PA and alcohol drinking (Aarnio et al., 2003; Paavola et al., 2004). A 13 year follow-up study (903 Finnish subjects followed from 15 to 28 years old), found that alcohol use and PA were significantly associated ($p < .05$) only at the age of 21 years ($r = -.16$), and not during adolescence (age = 15 years; $r = -.01$) (Paavola et al., 2004). Aarnio (2003) found that the frequency of heavy drinkers increased systematically as the PA level decreased, and the frequency of non-users decreased when the PA level increased. However, in the three year follow up alcohol use was no longer associated with persistent exercise or persistent inactivity (Arnio, 2003).

Associations between fruit and vegetable intake and PA

Cross-sectional studies

Evidence indicates that adolescents who are active show positive associations with healthy eating (i.e. great number of healthy carbohydrates and healthy fats, and great daily servings of fruit and vegetables) (Delisle et al., 2010; Lowry, Wechsler, Galuska, Fulton, & Kann, 2009; McAloney et al., 2014), suggesting a link between both behaviours (Pearson et al., 2009).

A study including 3914 early adolescents from UK found strong associations between meeting the recommendations for PA and fruits and vegetables consumption. The observed ratio was OR= 1.36 for boys and OR= 1.47 for girls (McAloney et al., 2014). The Helena study conducted all over Europe (including Spain) showed that males and females in the high active group were associated with a higher consumption of fruit compared to the low active group (130.3g Vs 106.2g). For males, differences between groups (active vs inactive) were also significant (p .04) for the vegetables consumption (147.8g Vs 131.5g) (Ottevaere et al., 2011). Finally, the AVENA study found that fibre consumption (typically encountered in fruits and vegetables) among adolescent boys to be associated with higher levels of PA (R=0.11; p=0.02) (Warnberg et al., 2006). In summary, cross-sectional studies across industrialized countries confirm that being physically active during adolescence is positively associated with a greater fruit and vegetable intake.

Longitudinal studies

Longitudinal studies suggested that food choice in adolescence, influences later food choice patterns (Due et al., 2011; Takaoka & Kawakami, 2013). However, the amount of studies specifically associating PA and fruits and vegetables consumption during late adolescents and early adulthood is poor worldwide, including Spain. Uniquely, one longitudinal study from Finland, reported positive associations between being physically activity and showing better eating habits (regular breakfast) but only among boys (Aarnio et al., 2003).

Associations between sedentary behaviour and PA

Cross-sectional studies

While research on sedentary behaviour focuses on different domains including screen time or talking with friends (Fitas & Virella, 2014), most research studying associations between sedentary behaviour and PA is based on screen time (Utter et al., 2003).

The evidence about the associations between PA and sedentary behaviour is not conclusive; in some cases the association is positive (Utter et al., 2003; Feldman, Barnett, Shrier, Rossignol, & Abenhaim, 2003) while other times there is a consistent inverse association between sitting time and PA (Fountaine, Liguori, Mozumdar, & Schuna, 2011; Melkevik, Torsheim, Iannotti, & Wold, 2010; Dutra, Kaufmann, Pretto, & Albernaz, 2015; Mota et al., 2007).

On the one hand, some studies find a positive association between screen time and levels of PA. Utter et al. (2003) found boys reporting high TV/video use consumed almost 400 kcal more per day than those in the low-use category. Similarly, girls reporting high computer use consumed more than 300 kcal more per day than girls reporting low use (Utter et al., 2003). Another study detected different levels of involvement in PA by type of sedentary behaviour (Feldman et al., 2003). Time spent in productive sedentary behaviour (reading or doing homework and working on computers) was associated with an important increased on PA (r=1.7). Whereas, time spent watching TV and playing videogames was associated with small increase on PA (r=1.1) (Feldman et al., 2003). A recent systematic review suggests that high levels of PA can coexist with high levels of sedentary behaviour or vice-versa (Leech, McNaughton, & Timperio, 2014).

Contrarily, TV viewing also was associated with an inactive lifestyle (not participating in at least 30 minutes of moderate PA on 5 or more days a week) among a group of US high school students (n=15.349) (Lowry et al., 2009). Eight hundred and fifteen girls (mean age = 14.5 years) from Portugal, reported that an increase of 1 hr of TV watching was a significant predictor of non-leisure time PA (OR = 0.38) (Mota et al., 2007). An Inactive lifestyle was significantly associated (OR = 1.65) with spending ≥ 5 hours/day in front of TV (Lowry et al., 2009). Fountaine et al. 2011, found that physically active students from US (n=736) reported significantly fewer minutes of total screen time than inactive students (+30 min/day; p=.047). However, active individuals spent more time sitting for homework (+14 min/day) (Fountaine et al., 2011). Similarly it was found that teenage students (n=205.939) from 41 different countries, including

Spain, who exceed 2 hrs daily of cumulative screen use, report doing 60 minutes of MVPA on average .21 days less per week for girls and .16 days per week for boys than those with lower screen time (< 2 hrs) (Melkevik et al., 2010). Indeed, systematic reviews found a consistent inverse association between screen time and PA (Costigan, Barnett, Plotnikoff, & Lubasn, 2013).

Longitudinal studies

The two longitudinal studies identified that levels of PA decreased while sedentary behaviour increased from adolescence to young adulthood. The first study reported substantial declines in MVPA among girls (decreasing from 5.1 to 3.5 hours/week from mid- to late adolescence) and increases in leisure-time computer use particularly among boys (increasing 10.4–14.2 hours/week from mid- to late adolescence). However, computer use also increased among older girls during this transition period (8.8-12.5 h/week). These results indicated that adolescents experienced unfavourable changes in physical activity patterns from adolescence to young adulthood; showing consistent decreases in moderate to vigorous PA and increases in leisure-time computer use (Nelson, Neumark-stzainer, Hannan, Sirard, & Story, 2006b).

Similar results were found in a longitudinal study conducted among British adolescents (Brodersen, Steptoe, Boniface, & Wardle, 2007); showing consistent declines in PA patterns between adolescence and young adulthood, with this decline being less accentuated for sedentary behavior. Results showed that 33% of adolescents who achieved PA recommendations failed to achieve five or more sessions of MVPA per

week as adults. Instead, 17% of adolescents, who engaged in ≤14 hours of screen time per week, increased their screen time into adulthood (Gordon-Larssen et al. 2004).

A third longitudinal study followed a group of English adolescents (from 12 to 15 years), indicating that the proportion of sedentary time significantly increased during school (+8.23%), after-school (+6.99%) and at weekends (+6.86%); while a parallel decrease was found in the proportion of time spent in leisure time PA during school (-7.62%), after-school (-7.01%) and at weekends (-6.72%) (Harding, Page, Falconer, & Cooper, 2015).

Finally, a group of Estonian adolescents (n = 345) were followed from 12 to 14 years old (22 months) (Raudsepp, Neissaar, and Kull, 2008), showing a significant decrease in indices of PA (-10.4 METs/day) and increase in sedentary behaviors (+0.5 blocs/day) across the 22 months. Furthermore, there were statistically significant and negative direct effects from the television watching/video game playing (β= –.47) and "other sedentary behaviors" (β= –.41). Therefore, changes in sedentary behaviors across time were inversely associated with a change in PA across time (Raudsepp et al., 2008).

Summary of key issues

- Cross-sectional data shows that PA may be a protective behaviour against cigarette smoking.
- Cross-sectional data shows positive association between alcohol consumption and PA in adolescents.
- Fruit and vegetable intake is more common amongst active and persistently active boys and girls.
- The association between sedentary behaviour and PA is inconclusive: Some of the studies suggest that these behaviours do not displace one another; while other studies expose that some sedentary behaviours (especially screen time) may be associated with an inactive lifestyle.

Limitations of the literature.

- The amount of longitudinal studies across late adolescence and early adulthood combining PA and alcohol consumption is limited.
- The vast majority of studies associating sedentary behaviour with different types of PA during adolescents and early adulthood focus in computer use, TV viewing or TST.
- The amount of Spanish studies associating PA with other health related behaviours, especially longitudinally, is scarce.
- There is lack of Spanish studies indicating how these results may influence and promote the National Health Plans.

Sports participation during adolescence: Prevalence, tracking and Influence on adopting health-related behaviours in adolescents and early adults

Sport is the most preferred option amongst adolescents and early adults to achieve and maintain regular levels of MVPA at leisure time (Pfeiffer et al., 2006; Nelson, Gordon-Larsen, Adair, & Popkin, 2005). Nelson et al. (2005) studied 11,957 adolescents finding that high sport participation in parents and adolescents overall, increased the likelihood of adolescents meeting current PA guidelines (OR=5.84) during early adulthood (OR=2.58) (Nelson et al., 2005). A year later, Pfeiffer et al. (2006), identified that sport participation contributes to overall vigorous PA across late adolescence; Girls who played sports in eighth and ninth grade were more likely to engage in VPA in 12th grade (OR = 2.03) (Pfeiffer et al., 2003).

From then, other studies have reinforced this finding: a Portuguese study (n = 208) identified that boys engage more in sports in the clubs context, and girls had more participation in sports in the school context, although both were found to be a stronger predictor of total activity involvement (OR = 5.26 for boys; OR = 8.98 for girls) (Silva et al., 2010). Likewise a study conducted in Spain with 3503 students (aged 12-18 years) concluded that participation in organized activities and in sport competitions increases the chances of achieving enough MVPA in adolescence (OR = 2.92 and OR = 2.90 respectively) (Serrano-Sánchez et al., 2011). Finally a very recent study involving 973 children and adolescents aged 10-18 years old measured sport participation (using self-reported measurements) and MVPA (using accelerometers). Their findings indicate that adolescents who were engaged in organized sports were more likely to achieve

MVPA recommendations (OR=1.64) (Marques, Eklelund & Sardinha, 2015). A systematic review confirmed this belief concluding that sport participation is likely to contribute to higher levels of PA among youth (Ekelund et al., 2011).

Moreover, participating in organized sports and participation in relatively intensive endurance sports during school age is a reasonable predictor of PA in adulthood (Tammelin et al., 2003; Telama et al., 2003; Kraut, Melmade, Gofer, & Froom (2003)) In Kraut et al. (2003) found that organized school age sporting activities were related to future leisure time PA in the sample of 3687 industrial workers (OR=3.55) (Kraut et al., 2003). Another longitudinal study with 1,606 participants followed, observed that large frequency of participation in sport-club training seasons increased the probability of higher activity in adulthood, more among females (OR=6.0) than males (OR=5.1) (Telama et al., 2006). Tammelin et al. (2003) measured 7,794 young adolescents at 14 and at age 31. The results indicate that participation in sports in adolescence every other day was significantly associated with being physically active in adulthood (OR = 2.5 for males; OR = 2.0 females). Another longitudinal study concluded that high levels of continuous PA (being persistently active); from age 9 to 18 significantly predicted adult PA. In fact, the results showed that males who participated ≥6 years in one sport were 19 times more likely of being active in adulthood than continuous inactive (Telama et al., 2006). Similarly Rangul et al. (2011) found that boys and girls who played “no sport” were 13–14 times more likely to remain inactive, compared with those who played sport. However the results are not always consistent especially among girls. A study with 1,709 adolescents found that males and females who did participate in sports during high school (mean age = 15.9 years) reported a decline in

MVPA when adults (mean age = 20.4 years) (1.7 hours per week and 2.6 hours per week respectively) (Walters, Barr-Anderson, Wall, & Neumark, 2009).

The prevalence of sport participation is high in Spanish adolescents (64% of adolescents aged 15-17 years practice one sport in Spain) (García, Rodríguez, Valverde, Sánchez, & López, 2011) and in Catalonia (65% of high school students) (Nebot et al., 2010). The percentage of sport participants is higher among boys compared to girls (+30%) (Nebot et al., 2010), and the type of preferred sport differ between genders; boys usually report involvement in team sports for example, football, basketball or hockey (Garcia et al., 2011), while girls appear to report more involvement in individual sports/activities like dance, swimming or tennis (Consejo Superior de deportes, 2010).

Associations between sport participation and health related behaviours

This section will present a review of cross-sectional and longitudinal data to examine how sport participation relate to other health-related behaviours both cross-sectional and longitudinally since sport participation clearly contributes to overall MVPA across late adolescence and early adulthood (Marques et al., 2015; Pfeiffer et al., 2006; Nelson, Gordon-Larsen, Adair, & Popkin, 2005). The bibliographic table of the studies can be found in the appendices (appendix 1).

Database used, key words, custom date range and articles reviewed

The research was conducted using three main databases: Pubmed, Scopus and Scholar google. The research was limited by date (custom date range 01/01/2000-31/12/2015) and country (only articles from developed countries were selected to be consistent with the present research).

In pubmed the specific words “Adolescent sport + substance use” were introduced, and 121 different articles appeared for this first search. In Scopus, the words “adolescents sport participation” AND “substance use”, found a total of 715 articles. Furthermore the words: “associations between sport participation + cigarette consumption + adolescents”, with 5 results appearing in pubmed and 11 in scopus; “associations between sport participation + alcohol consumption + adolescents”, encountered 25 results in pubmed and 32 in scopus. “Fruit vegetable consumption + adolescents” produced 16.800 results in google scholar, 1290 in pubmed and 1877 in scopus. “Adolescents sport participation + sedentary behaviour” encountered 104 different articles in pubmed and 92 in Scopus. Another set of words were used for sedentary behaviour: “screen time + sport participation + youth”. In this case, 24 results appeared in pubmed and 6 in scopus.

Six cross-sectional studies and 4 longitudinal studies were selected finding associations between sport participation and cigarette consumption. No Spanish studies for cross-sectional or longitudinal research. Seven cross-sectional studies and 2 longitudinal found associations between sport participation and alcohol consumption. No Spanish

studies for cross-sectional or longitudinal research. Six cross-sectional and 1 longitudinal found associations between sport participation and fruit and vegetable intake. No Spanish studies for longitudinal research. Six cross-sectional studies and 2 longitudinal found associations between sport participation and fruit and vegetable intake. No Spanish studies for longitudinal research.

Associations between tobacco consumption and sport participation

Cross-Sectional studies

The majority of the cross-sectional studies reviewed (n=5) agree persistently active adolescents smoke less than inactive adolescents (Terry-McElarth, O'Malley, & Johnston, 2011; Nerin et al., 2011).Indeed, Lisha & Sussman (2010), on their systematic review, found an inverse relationship between sports and cigarette use on 14 out of 15 studies.

Exercise and athletic team participation was associated negatively to cigarette smoking with high schools students from US (N=45.000) (b = -0.12(exercise); b = -0.08(athletic team participation) (Terry-McElarth, O'Malley, & Johnston, 2011). In Norway they compared 602 athletes and 354 controls; their results showed that not participating in organized sports was a predictor of smoking (OR=4.99) among youth; and similar results were found among university students, although the differences were not significant ($p \geq 0.05$) (Nerin et al., 2011).

Although a negative association has been demonstrated in several articles, there are some factors which influence this relationship. (i) Type of sport practiced: Team sports participation is not associated with cigarette smoking in the northern European countries, contrarily to what happen with the use of snus (moist powder tobacco), which is associated with team sports participation (OR=2.8) (Martinsen & Sundgot-Borgen, 2014). A study conducted in France (n = 10.807) found that the regular practice of a strength or combat sport was linked to daily and heavy smoking for boys and girls (OR = 1.16 and 1.70 respectively) (Peretti-Wattel et al., 2001). (ii) The athletes level of practice. Diehl, Thiel, Zipfel, Mayer, and Schneider (2014), found that compared with non-elite athletes, elite athletes showed less risky behaviours except for binge drinking. In their study found that the number of daily cigarettes in current smokers was 2.1 (SD=1.6) for elite athletes and 7.8 (SD=5.8) for non-elite athletes. This can be explained with the findings from Nerin et al. (2011), were a total of 98.8% of the subjects were of the opinion that smoking reduced physical performance, supported as well by Amos & Bostock (2007) and Peretti-Watel et al. (2001), who found that the proportion of daily smokers decreased with intensity of sporting activity ($p < 0.001$ for boys and for girls).

Longitudinal studies

A longitudinal study from USA which followed late adolescents from 9 to 11 grades found that adolescents with decreasing or erratic sport participation were nearly three times more likely than adolescents with high participation to be current smokers in eleventh grade (Rodrigues & Audrain-McGovern, 2004). Another longitudinal study

from US (N=361 followed from grade 9 to grade 12) identified that participating in at least 1 team sport, had a significant negative effect on smoking progression (z = -3.85, P<.001) (Audrain-McGovern et al., 2006).In this context, become significant the findings from Kwan, Bobko, Fulkner, Donnelly, and Cairney (2014) noting that the transition point from adolescence to early adulthood may be a critical period to reduce or prevent the use of drugs through sport, at least when referring to tobacco consumption.

Associations between alcohol consumption and sport participation

Cross-sectional studies

The links between sport participation and alcohol consumption are strong. Lisha & Sussman (2010) on her revision study found that in 22 out of 29 studies, sport participation was positively associated with alcohol consumption. This is not the only systematic review reaching equal conclusions; Martens, Dams-O'Connor, & Beck (2006), after reviewing several national studies, concluded that in general, college athletes consume more alcohol, engage in more frequent heavy episodic drinking, and experience more negative alcohol-related consequences than non-athletes. Finally, Kwan et al. (2014), showed a significant positive association between sport participation and alcohol use in 82% of their 17 longitudinal studies reviewed.

The cross-sectional studies exploring the relationship between sport participation and alcohol consumption highlight two main determinants for this association.

First of all, some sports are more closely associated with an increased likelihood of alcohol use. In general studies agree that technical sports, more specifically team sports, are associated with more alcohol consumption among teenagers. Peretti-Watel et al. (2001) found that boys playing in team sports reported higher levels of recent drunkenness than those doing athletics sport (OR=1.25 Vs OR=0.76), and for girls, the main differences between team sport players and athletic sport participants were on repeated use of alcohol (OR=1.40 Vs OR=0.73) (Peretti-Watel et al., 2001). Another study conducted in France among late adolescents (N=816, mean age = 18.3 years) found that 84.1% of the team sport players had drunken alcohol at least once per 15 days, compared to 61.8% of the individual athletes (Lorente, Souville, Griffet, & Grélot, 2004). Moreover, team sport participants from high school had a continued positive relationship with binge drinking in all the cross-sectional studied years (from 1991 to 2009) (b = .026) compared to exercise participants who showed a negative association (b = -.029) (Terry-McElrath et al., 2011); in this context Martens et al. (2006) in their systematic review concluded that although *prevalence rates of alcohol use among athletes only slightly exceed those among non-athletes, heavy episodic drinking appears to be far more common among athletes* (p.307).

Secondly, in general male athletes are more ready to drink than female athletes (Diehl et al., 2014; Martens et al., 2006); although with some exceptions found in the literature (Martinsen & Sundgot-Borgen, 2014).

The prevalence of weekly consumption of beer among a group of elite athletes (n = 1138; mean age = 16.3 years) was higher among boys than girls (26.4% and 5.8% respectively), as well as the prevalence of binge drinking (32.7% Vs 20.8%) (Diehl et al., 2014). Furthermore a logistic regression showed a significant link between team sports and recent drunkenness for boys (OR=1.28) but not for girls (OR=0.84) (Aarnio et al., 2003). However, some exceptions can be found in the literature. A recent study conducted in Norway found that female athletes (mean age=16.5 years old), were more prone to drink alcohol than males (46.3% Vs 31.0%; p <.001) (Martinsen & Sundgot-Borgen, 2014). It is important to note that those sports associated with increased likelihood of alcohol use can be different for males and females. A study run in USA found that surfers, skateboarders and tennis players (males) were significantly more likely to use alcohol than other groups. Amongst females, the activities more related to alcohol consumption were: dancing, cheerleading, gymnastics, skateboarding and surfing (Moore & Werch, 2005).

Longitudinal studies

Longitudinal studies indicate that this association revealed in the cross-sectional studies may track across adolescence and early adulthood. A group of Norwegian adolescents (n=3251) were followed from 13 to 19 years old, and it was found that those who were in team sports had increase growth in alcohol intoxication (b = 0.06) compared to those in endurance sport (b = -0.06); this particular study concludes that team sports *fosters socialization into normative behaviour, which is getting drunk, but abstaining from illicit drugs.* (Wichstrom & Wichstrom, 2009). However, other studies

emphasise that no only sport participation affects lifelong alcohol consumption. Peck et al. (2008) conducted a longitudinal study following 1000 subjects from 12 to 28 years old. Their results revealed that the relation between adolescent sport activity and age 28 heavy alcohol was higher for sport participants who were also using more than the average amount of alcohol and other drugs at age 18.

Associations between fruits and vegetables intake and sport participation

Cross-Sectional studies

A systematic review conducted by Nelson et al. (2011) found that youth involved in sport were more likely to consume fruits and vegetables and all the cross-sectional studies reviewed reinforce this finding (Vella, Cliff, Okely, Scully, & Morley, 2013; Taliaferro, Rienzo, & Donovan, 2010).

In Australia a study using a representative sample of 12.188 adolescents aged between 12 and 17 years old found that students who reported ≥210 min/week of organized sport participation were between 1.32 and 2.90 times more likely to achieve the fruits and vegetables consumption guidelines, compared with those who reported ≤60 min/week (Vella et al., 2013). A study conducted in USA found that the relationship between male sport participation and increased fruit consumption remained consistent across years (OR=2.56). The relationship regarding vegetable consumption was also positive and significant but smaller (OR=2.08). Among females, white female

athletes were more likely than non-athletes to consume fruit (OR=2.29) and vegetables (2.62) (Taliaferro, Rienzo, & Donovan, 2010).

Longitudinal studies

Any study specifically associating sport participation and fruits and vegetables consumption during late adolescents and early adulthood was found. This present work will contribute to understand better whether sport participation and fruits and vegetables intake are related, considering other variables such as gender or type of sport.

Associations between sedentary behaviour and sport participation

Cross-sectional studies

Although there is a good amount of studies associating PA and/or MVPA with sedentary behaviour the number of articles correlating uniquely sport participation with sedentary behaviour during the last years is, at least, limited. In the end, uniquely 4 studies were selected, considering either total sedentary behaviour or specifically screen time and its association with sport participation. Moreover the few available studies do not present conclusive results about the association between these two behaviours (Serrano-Sanchez et al., 2011; Allen & Vella, 2015; Marques et al., 2015; Buschaert et al., 2015).

A study conducted in Australia among early adolescents (age range = 12-13 years), demonstrated that sport participation and TST were inversely correlated ($r = -.10$) (Allen & Vella, 2015). A study from Spain explained that for each hour increase in total screen-time, the MVPA level fell by 7.5% (OR = 0.93) in boys. They showed that participation in organized PA (sport) decreased the risk of excessive use of TV by 33% in both sexes and video games by 59% in boys (p=0.05) (Serrano-Sanchez et al., 2011). However, other research found no associations between organised sport participation and time spend sedentary, showing very similar sitting time between sport participants and non-sport participants adolescents (557 min/day Vs 563 min/day) (Marques et al., 2015).

Longitudinal studies

One longitudinal study looked for associations between sport participation and sedentary behaviour (Busschaert et al., 2015). Baseline data was retrieved from elementary schools in Flanders (Belgium) (1.957 children (mean age = 9.9). After a 10-year follow-up period, 655 early adults (mean age = 19.9) filled out an adapted questionnaire on sedentary behaviour, of which 593 contained full data at baseline and follow-up. Although some variables, like drinking more soda, predicted more time in front of screen at follow up ($p \leq .02$), no significant ORs were found when observing sport participation (Busschaert et al., 2015).

The lack of longitudinal research across adolescence and early adulthood associating sport participation and sedentary behaviour (Pearson, Braithwaite, Biddle, Van Sluijs,

& Atkin, 2014; Costigan et al., 2013), complicates the possibility to have conclusive results regarding how sport participation influences tracking of sedentary behaviours among adolescents.

Summary of key issues

- The literature indicates that PA among adolescents is predominantly associated with sport participation.
- Sport participation is common amongst Spanish and Catalan adolescents.
- The transition point from adolescence through early adulthood may be a critical point to reduce or prevent the use of drugs through sport.
- There is an inverse relationship between sports and cigarette use and a positive association between sport participation, especially team sports, and alcohol use.
- Youth involved in sports are more likely to eat fruits and vegetables.
- There is a lack of studies, both cross-sectional and longitudinal, associating sedentary behaviour with sport participation which makes difficult to gather conclusive results.

Limitations of the literature

- There is a lack of consent and deep research about gender differences on the associations between sport participation and alcohol use.
- A recent systematic review found 16 of 17(94%) of the longitudinal studies associating sport participation and alcohol use were conducted in the US.
- The type of sports practiced is not properly divided in the majority of the studies associating tobacco use or fruit and vegetable intake with sport participation.
- It is noteworthy the lack of longitudinal studies analysing the associations between fruit and vegetable intake and sport participation from late adolescence to early adulthood.
- The lack of longitudinal studies trying to find and explain associations between sport participation and sedentary behaviour is a shortfall in the research.
- The amount of studies from Spain associating sport participation and health related behaviours is poor and absent when looking for longitudinal studies.

Rationale for the methodology used.

Traditionally, there are two major research paradigm positions that embrace scientific investigations: The Positivist paradigm- which underlines quantitative methods- and the Constructivist paradigm -which underlines qualitative methods (Sparkes, 1992).

Although each paradigm has its own advantages and disadvantages, they can all be used for three customary purposes of research: exploration, description and explanation (Walliman, 2011). For the present study, the positivist paradigm was considered the most adequate as it holds research that investigates possible relationships between phenomena in order to establish if correlation exists and, if so, to which extent (Walliman, 2011). Quantitative methods were used to establish facts, identify relationships between variables, allow prediction and strive for generalizability (Bailey, 1997).

The following reasons were identified to embrace this PhD thesis within the main features of the quantitative methods: (i) as observed through the background, a minor amount of cross-sectional and longitudinal studies have been developed in Spain and Catalonia associating PA, sport participation and other health-related behaviours, with quantitative methods forming an adequately basis for this needed investigation (Bailey, 1997); (ii) quantitative methods allow to reach large sample sizes of precisely defined subjects who will be representative of those in the population (Walliman, 2011) which is a key methodological issue in cross-sectional and longitudinal studies; (iii) quantitative methods seek evidence to prove or disprove hypothesis or research

questions that were developed before the study (Bailey, 1997) as it is also required by this PhD thesis; (iv) quantitative methods can be cost-time effective providing responses that are completely anonymous with a fair chance of getting a true reply (Walliman, 2011) and finally; (v) quantitative research designs are predetermined, structured and do not change during the course of the study (Bailey, 1997), which was also convenient for our longitudinal research.

CHAPTER 2.

RESEARCH QUESTIONS

CHAPTER 2. RESEARCH QUESTIONS

Study 1:

Which are the health-related behaviours patterns of 16 years-old adolescents from Osona (Barcelona)? Do levels of PA in relate to the adoption of other health-related behaviours during adolescence?

Study 2

Do levels of PA and prevalence of sport participation relate to the adoption and maintenance of other health behaviours during adolescence and early adulthood?

Study 3

Does sport participation at age of 16 influence the adoption and maintenance of other health related behaviours across late adolescence and early adulthood? What factors affect the abandon of sport participation and the reduction of MVPA during late adolescents and early adulthood?

CHAPTER 3.

STUDY 1 – Adolescents' lifestyle patterns in Osona: Do they relate to physical activity levels?

CHAPTER 3. STUDY 1: ADOLESCENTS' LIFESTYLE PATERNS IN OSONA: DO THEY RELATE TO PHYSICAL ACTIVITY LEVELS?

Overview and purpose

Physical inactivity is a major contemporary health issue that affects the development of NCDs among the population (WHO, 2014). Inactivity starts during childhood and adolescence with low levels of PA being encountered in teenagers worldwide, especially among girls (Hallal et al., 2012; Ruiz et al., 2011). Since (i) the literature is not conclusive about whether being physically active during adolescence is related to the adoption of other health-related behaviors (Ottevaere et al., 2011; Musselman & Rutledge, 2010) and, (ii) studying specific target groups in specific cultural contexts is a must do to develop efficient lifestyle interventions (Greaves et al., 2011; Sallis et al., 2008), study 1 will aim to:

- Determine patterns for physical activity and other health-related behaviours among a representative sample of adolescents from Osona (Barcelona) in their last year of secondary compulsory school.
- Identify how adolescents´ lifestyle patterns of 16 years old students relate to PA levels in this specific cultural context of Osona (Barcelona).

Study design and sample

A cross-sectional design was used. The study population were adolescents in their last year of the compulsory secondary education (16 years of age) from a Catalan county in Barcelona during 2011 (Osona) (n=1558; 833 males, 725 females; Catalan Institute of Statistics, 2012). Adolescents born in 1995 were chosen for two main reasons: i) at this time all of them were ESO students (Obligatory Secondary Education) so it was easier to go to schools and reach a large amount of subjects, ii) as this is meant to be a 4 years longitudinal study, the subjects would be followed during the transition from adolescence to adulthood.

A sample size of 764 adolescents for that age group and specific context was considered adequate to (i) ensure that errors of estimation in adolescents lifestyles´ means and proportion were limited within desired limits (p=0.5) and, (ii) to provide a power level of 80% according to previously published studies in Spanish adolescents (Ortega et al, 2005) (appendix 2). Exclusion criteria were adolescents with relative/absolute contraindications for practice physical activity as well as adolescents with chronic health diseases affecting their physical activity practice. Any participant was excluded for the present study. The study was approved by the Ethics Committee of the University of Vic-Central University of Catalonia (2011). All participants signed written informed consent before completing the survey.

Survey

The survey aimed to describe adolescents´ (i) PA levels during leisure time; (ii) achievement of current physical activity recommendations for health; (iii) alcohol and tobacco consumption (iv) fruits and vegetables consumption, and (v) socio economic and demographic status (gender, age, parents educational levels, socio-economic status).

The 38-item questionnaire (appendix 3) was firstly piloted in a convenience sample of adolescents (n=30) to test whether the questionnaire was comprehensible and appropriate, and the questions were well defined, clearly understood and presented in a consistent manner (Lancaester, Dodd, & Williamson, 2004).

Variables measured and questionnaire used

Physical activity

The PAQ-A is a self-administered, 7-day recall instrument. The PAQ-A provides a general measure of PA for youth, it is appropriate for those who are currently in the school system (Kowalsky, Crocker, & Kowalsky, 1997) and, it is a validated tool used in a large amount of studies (Adeniyi et al., 2011; Crocker et al., 2003; Gurd & Klentrou, 2002). The Spanish version of the PAQ-A shows an acceptable reliability test-retest with an Interclass Correlation Coefficient (ICC) of 0.71 and an internal consistency of

α=0.74 (Martínez-Gómez et al., 2009). To score this questionnaire we used the specific manual (Kowalski, Crocker, & Donen, 2004). The PAQ-A has 9 different items, and to score the questionnaire we find an activity score between 1 and 5 for each item (excluding item 9, which is only to identify students who had unusual activity during the previous week). Once we have a value from 1 to 5 for each of the 8 items we take the mean of these 8 items, which results in the final PAQ-A activity summary score. A score of 1 indicates low PA, whereas a score of 5 indicates high physical activity. PA was finally categorized in three groups according to previous studies (Adeniyi et al., 2011):

- Low levels of PA (PAQ-A = 1 – 1.99)
- Medium levels of PA (PAQ-A = 2-2.99)
- High levels of PA (PAQ-A = 3-5)

The PACE questionnaire (Physician-based Assessment and Counselling for Exercise) it was developed as an easy tool to measure general levels of PA amongst adolescents (Martínez-Gómez et al., 2009). The questionnaire is divided in 2 questions measuring (i) how many days during the last week, and (ii) how many days during a normal week, the adolescent complete, at least, 60 minutes of PA. Considering the score of the present questionnaire, the adolescents will be considered active if they do, at least, 60 minutes of PA 5 days a week (Patrick et al., 2001). This questionnaire was found two have a satisfactory correlation to measure PA in Spanish adolescents (r = .40) when compared with objective measurements, likewise a good reliability test-retest (CCI = .77) was evaluated (Martínez-Gómez et al., 2009). To score the PACE questionnaire we

divided the subjects according to whether or not they achieved the worldwide PA recommendations for kids and adolescents (ACSM,2006)

Alcohol and tobacco consumption

To measure these variables we used the FRISC questionnaire (not an abbreviation) (Comin et al., 1997). The FRISC questionnaire is the Spanish version of a questionnaire recommended by the WHO to measure substance use among adolescents (Smart et al, 1980). For our final questionnaire we used three questions about alcohol consumption referring to alcohol consumption during their entire life, consumption during the last month, and frequency of consumption during the last month; and three questions about tobacco consumption referring to use of cigarettes and frequency of smoking. The FRISC questionnaire has shown high correlation parameters regarding alcohol (r= 0.66-0.72) and tobacco consumption (0.79 - 0.82) as compared with other question measuring the same parameters. Moreover, it has been widely used within the Spanish context (Garcia et al., 2011; Paniagua & Garcia, 2003). This questionnaire allows us to observe prevalence and frequency of substance use among adolescents (Comin et al., 1997).

Fruit and vegetable consumption

The Spanish version of the STEPS instrument (Organizacion Mundial de la Salud (OMS), 2003) is a worldwide used and well accepted questionnaire to measure different lifestyle behaviours such as alcohol consumption, tobacco use or PA levels (Kelishadi et

al., 2008; Yadav & Krishnan, 2008). For the purpose of the present research we uniquely use the questions about fruit and vegetable intake. Four questions (two about daily fruit intake and amount of pieces per day and two about daily vegetable intake and number of pieces per day) were extracted from the Spanish version of STEPS instrument. The show cards specifically made for this questionnaire were used to show the typical fruits and vegetables from our region and the serving size. To score these questions, the mean of fruit and vegetables consumed per day was calculated.

Socio economic and demographic information

Socio economic and demographic information (Departament de salut i Institut d'estadística de Catalunya, 2009) used in the final questionnaire was: body mass index (BMI; weight (in kg)/height2 (in m)), age, gender, nationality; parents' study level, parents' actual working situation, and approximate family income. The mean of the total Body Mass Index (BMI) (Mass (Kg)/Height $(m)^2$) was calculated.

Our final questionnaire had 38 questions most of them close-ended questions with a pre-existing set of answers. We used some techniques to make the questionnaire handier and more motivating for the students: to use a close and familiar language, to compress it to avoid too many pages, to use motivating messages and to use funny and recognized images (appendix 3).

Data collection

The Department of Education in Osona endorsed the study and, provided the complete list of high schools that offered secondary compulsory education (n=25) in the county at 2011. These schools were spread around twelve different towns including Vic (n=7), Torelló (n=3), Tona (n=3), Manlleu (n=3), Centelles (n=2), Masies de Voltregà (n=1), Prats de Lluçanés (n=1), Roda de Ter (n=1), Taradell (n=1), Calldetenes (n=1), Sant Quirze de Besora (n=1) and Sant Julià de Vilatorta (n=1) (appendix 4).

Invitation letters were sent to directors of each school, requesting permission for their 16 years-old students to complete the survey. Detailed information about the study, the questionnaire and the written consent form for students were provided (appendix 5). An email or a phone call was then conducted to each director to confirm participation. In each school that engaged the study, a teacher/tutor for the 16th years-old students voluntarily agreed to organise a time and a classroom where the questionnaire could be submitted and filled in by the students. When the day and time were set (mostly during student´s tutorial time or PE class), the researcher went to the classroom, explained the study to students and requested their participation to complete the survey. A written informed consent was signed before completing the questionnaire (appendix 6). Students handled in the consent form and the completed questionnaire to the researcher immediately after. The survey was conducted between March and May 2011.

Thirteen centres out of 25 accepted to participate in our project (52%) (appendix 7). The main reasons to avoid participation were: (i) lack of time, (ii) lack of interest, (iii) too many activities already programmed for that group of students, and (iv) too many questionnaires being filled in by students already during that academic year. The total number of schools visited and the students surveyed in each school is now detailed (Table 2).

Table 2. *Schools, place and number of students surveyed in each school.*

School	Place	Students (n)
1.Institut la Plana	Vic	67
2.Escorial	Vic	80
3.Institut de Vic	Vic	57
4.Col·legi Pare Coll	Vic	49
5.IES Pere Barnils	Centelles	64
6.IES Castell del Quer	Prats de	70
7.IES Taradell	Taradell	55
8.IES Cirvianum	Torelló	64
9.Escola Sagrats Cors	Centelles	9
10.SES de Calldetenes	Calldetenes	49
11.Casals Gràcia	Manlleu	25
12.Escola Vedruna	Tona	48
13.Escola Rocapravera	Torelló	27

Statistical analysis

Data cleaning was carried out according to the following procedure (Van den Broeck et al., 2005): (i) when a participant did not fill up a substantial amount of the questions in the survey (≥5questions) the case was deleted for the analyses; (ii) in some very specific cases (i.e. time spent sitting in class) we conducted mean substitution of missing values, by replacing the missing data with the mean values from the other

subjects (Kalton & Brick, 1996). Deductive imputation was also applied when a missing response could be deduced from responses to other items. For example, if the person missed to answer: *do you* currently smoke? But afterwards he answered he smokes 5 or more cigarettes a day, then we deduced he was a current smoker; (iii) carrying out a pairwise election while doing the analysis which means that SPSS included all available data for the analysis. All subjects deleted and the data replaced can be seen in the appendices (appendix 8).

Descriptive statistics (frequencies and descriptive) were conducted to assess percentage responses for socio economic and demographic variables, PA variables, alcohol, tobacco and fruit and vegetable consumption. Chi-Square tests, assessed differences in proportions between males and females, and associations between the different levels of PA and each lifestyle measured (alcohol, tobacco and fruit and vegetable consumption). For fruit and vegetable consumption, the Kruskal-Wallis test assessed associations with PA levels as data was not normally distributed. The analysis was performed using SPSS statistics.21.

Results

As a result the final sample was 695 subjects (45% of the potential sample; n=1558)) although missing data reduced N in the analysis (n=664). Considering we had a large sample, there was not a substantial reduction in statistical power and the pattern of missing values was completely random. Table 3 shows the final sample characteristics: age, BMI, gender, nationality, parents' education, parents´ income and employment, and health-related lifestyles.

Table 3. *Main characteristics of participants (16th years old from Osona).*

General measurements Mean(SD)	**N=664**
Mean age	16.2 (0.62)
BMI	21,14 (2.77)
Gender N(%)	
Men	330 (49)
Women	334 (51)
Nationality N(%)	
Spanish	550 (82.8)
Non-Spanish	93 (14.2)
Double-Nationality	20 (3)
Parents education N(%)	
Father studies primary school	97 (14.6)
Father studies secondary school	250 (38.0)
Father studies university	118 (18.0)
Mother studies primary school	75 (11.3)
Mother studies secondary school	246 (37.0)
Mother studies university	142 (21.0)
Parents Job N(%)	
Father currently working (%)	575 (86.7)
Mother currently working (%)	498 (75.0)
Family Salary N(%)	
Family salary ≤ 1200 Euros (%)	86 (13.1)
Family salary 1200 to 1800 Euros (%)	91 (14.0)
Family salary ≥ 1800 Euros (%)	228 (34.2)
They do not know the family salary (%)	257 (38.7)
Tobacco Consumption N(%)	
Current smokers	172 (25.9)
Daily smokers	120 (18.1)
Alcohol Consumption N(%)	
During last 12 months	504 (76.0)
During last month	384 (57.8)
Fruit and vegetable intake Mean(SD)	
Fruits per day	1.59 (1.24)
Vegetables per day	1.12 (1.09)
Fruit and vegetable per day	2.71 (2.20)

PA scores and patterns

The PACE questionnaire told us that 40% of the respondents were doing 2 days or fewer of 60 minutes PA per week. It is noteworthy that taking into account this questionnaire, which does not include PE classes, only 3% of the females and 5% of the males, achieved the ACSM recommendations for children and adolescents MVPA (ACSM, 2006) (Table 4). According to the PAQ-A score, PA levels reported a mean of 2.41 (in a 5 point-scale from low to high PA levels); with males reporting higher scores than girls (2.6 Vs 2.1), showing significant differences between genders (p=≤.001). Twenty-five percent of the sample (n=168) reported low levels of PA (PAQ-A score of 1-1.99), 58.3% (n=387) medium levels of PA (PAQ-A score of 2-2.99) and 16% (n= 109) high levels of PA (PAQ-A score of 3-5) (Table 4).

Patterns of PA identified that most participants either spent their free time doing activities that involved doing little physical effort (n=134; 20%) or doing physical things once or twice week (n=250; 38%). During their last 7 afternoons 15% of teenagers included sports or other MVPA for 5 or more days a week, with significant differences between genders (χ^2 = *86.71, p ≤.001)* (Table 4). During lunch time (from Mondays to Fridays), nearly 80% (n=531) of the sample spent their time sitting down, standing or walking around (Table 4). The most active day of the week was Saturday among both males and girls (59% and 30% respectively doing sufficient PA) while the most inactive day was Sunday with 29% of the males and 44% of the females doing any PA on this day.

Table 4. PA levels, perceptions of PA levels, and patterns of PA at free time, afetrnoon and lunchtime.

	Total N=664	**Males N=330**	**Girls N=334**	**p. value**
Days achieving 60 min of PA (PACE) N(%)				**≤.001**
0 days	62 (9.3)	13 (3.9)	49 (14.7)	
1 day	87 (13.1)	22 (6.7)	65 (18.5)	
2 days	119 (17.9)	37 (11.2)	82 (24.6)	
3 days	155 (23.3)	85 (25.8)	70 (21.0)	
4 days	126 (19.0)	91 (27.6)	35 (10.5)	
5 days	62 (9.3)	45 (13.6)	17 (5.1)	
6 days	27 (4.1)	21 (6.4)	6 (1.8)	
7 days	26 (3.9)	16 (4.8)	10 (3.0)	
PA levels (PAQ-A) N(%)				**≤.001**
Low levels	168 (25.3)	38 (11.5)	130 (38.9)	
Medium levels	387 (58.3)	206 (62.4)	181 (54.2)	
High levels	109 (16.4)	86 (26.1)	23 (6.9)	
PA patterns at free time N(%)				**≤.001**
All or most of my free time was spent doing things that involve little physical effort	135 (20.3)	35 (10.6)	100 (29.9)	
I sometimes (1 — 2 times last week) did physical things in my free time	250 (37.7)	102 (30.9)	148 (44.3)	
I often (3 — 4 times last week) did physical things in my free time	172 (25.9)	110 (33.3)	62 (18.6)	
I quite often (5 — 6 times last week) did physical things in my free time	66 (9.9)	49 (14.8)	17 (5.1)	
I very often (7 or more times last week) did physical things in my free time	41 (6.2)	34 (10.3)	7 (2.1)	
MVPA patterns at afternoon N(%)				**≤.001**
Never	131 (19.7)	38 (11.5)	93 (27.8)	
Once a week	100 (15.1)	24 (7.3)	76 (22.8)	
2-3 times a week	238 (35.8)	130 (39.4)	108 (32.3)	
4 times a week	98 (14.8)	66 (20.0)	32 (9.6)	
≥5 times a week	97 (14.6)	72 (21.8)	25 (7.5)	
PA patterns at lunchtime N(%)				**≤.001**
Sat down (talking, reading, doing schoolwork)	422 (63.6)	205 (62.1)	217 (65.0)	
Stood around or walked around	168 (25.3)	65 (19.7)	103 (30.8)	
Ran or played a little bit	50 (7.5)	39 (11.8)	11 (3.3)	
Ran around and played quite a bit	19 (2.9)	16 (4.8)	3 (0.9)	
Ran and played hard most of the time	5 (0.8)	5 (1.5)	0	

Preferred PA practiced by gender and levels of PA

The most frequently practiced activities for at least three times a week were walking, football, running and bicycle. Gender was also significantly associated with the type of sport practiced. Football, running, body building and bicycle were more frequently practiced by males than females (+41%, +20%,+19, +16%, respectively) while dancing and walking were significantly more practiced by females (+11%, +9% respectively) (Table 5).

Table 5. *Activities practiced more than twice a week among males and females.*

	Total	**Males**	**Females**	**p. value**
Activities N(%)				
Walking	286 (43.0)	126 (38.1)	160 (48)	≤.001
Football	179 (27.0)	158 (47.9)	21 (6.3)	≤.001
Running	171 (25.7)	119 (36.1)	52 (15.6)	≤.001
Bicycle	120 (18.1)	88 (26.7)	32 (9.6)	≤.001
Body building	94 (14.1)	79 (23.6)	15 (4.5)	≤.001
Basketball	91 (13.7)	68 (20.6)	23 (6.9)	≤.001
Dancing	68 (10.3)	15 (4.5)	53 (15.9)	≤.001
Swimming	34 (5.1)	19 (5.7)	15 (4.5)	.582
Racquet sports	30 (4.6)	17 (5.1)	13 (3.9)	.282
Volleyball	17 (2.6)	3 (0.9)	14 (4.2)	.003

Those participants who are in the high levels of PA according to PAQ-A (PAQ-A score of 3-5), are significantly reporting more activities (practicing or playing >twice a week) than the rest of the groups. Some of those activities are sport type (football or basketball) while other are more related to general MVPA (walking or running) (Table 6).

Table 6. *Type of activities performed (more than twice a week) according to the levels of PA.*

	Low Levels			Medium levels			High levels			p. value
	Total	**Males**	**Females**	**Total**	**Males**	**Females**	**Total**	**Males**	**Females**	
Activities (%)										
Walking	35.7	31.6	37.0	44.7	35.4	46.2	48.4	47.8	52.1	.02
Running	6.0	7.9	5.4	25.9	32.1	18.2	48.0	48.2	47.8	≤.001
Football	6.0	21.1	1.5	31.3	42.0	7.7	43.3	50.0	21.7	≤.001
Bicycle	7.2	15.8	4.6	15.1	20.3	10.0	40.8	45.3	34.8	≤.001
Body building	3.6	5.3	0.8	11.1	18.1	3.3	41.2	43.1	34.7	≤.001
Basketball	3.0	5.3	2.3	15.1	20.4	8.8	25.6	27.9	17.3	≤.001
Dancing	5.4	0	7.0	10.1	2.9	18.2	18.4	10.5	47.7	.01
Swimming	2.4	2.6	2.3	4.6	4.3	5.1	9.1	10.4	12.9	.10
Volleyball	1.8	0	2.3	2.6	1.5	3.9	3.7	0	17.3	.89

Associations of PA levels with other health-related lifestyles

PA levels were significantly associated with tobacco consumption (χ^2 = 10.65, *p* = 0.005) (Table 7). High levels of PA were associated to a lower proportion of current smokers. No significant gender differences were found for this association. However, high levels of PA among females were associated to a higher proportion of smokers (+ 11%) than in males. Among the smokers, those who are less active are more prone to smoke daily and to have a higher consumption of cigarettes per day (Table 7), although the differences between PA groups are not significant (χ^2 *= .64, p = .72;* χ^2 *= .64, p = .72).*

PA levels were not significantly associated with prevalence of alcohol consumption during the last month ((χ^2 = .624, *p* =0.732) (Table 7), with most alcohol drinkers across groups (n=444; 88.1%) drinking less than 4 units of alcohol a month. Although no

significant gender differences were identified for this association, the highly active males group was associated to drinking a higher amount of units of alcohol per month than females (+15.0%) (Table 7). Furthermore, significant differences (χ^2 *= 15.37, p = .05)* were encountered between PA levels and frequency of consumption among males. More active males showed more weekly alcohol consumption than their less active colleagues (+5.3%) (Table 7).

A significant positive association was identified between PA levels and fruit consumption (χ^2 = 12.16, *p* = .02) (Table 7). Associations remained significant across gender (χ^2 = 8.30, p=.05 for females; and χ^2 = 10.22, p=.04 for males); with high levels of PA being associated with eating more portions of fruit per day (+0.5 per day for females, +0.4 per day for males) (Table 6). Associations were identified between PA levels and vegetable consumption (χ^2 = 4.00, *p* = .18) (Table 7). When adding fruits and vegetables consumption into one single variable, PA levels were significantly related to fruits and vegetable consumption (χ^2 = 20.65, *p* < .04), with higher levels of PA being associated high a higher consumption of fruits and vegetables. The association remained significant across gender (χ^2 = 19.76, p=.03 for females; and χ^2 = 29.69, p=.01 for males).

Table 7. *Associations between PA levels, sport participation and health related behaviours.*

	Low PA levels			Medium PA levels			High PA levels			p. value
	Total N=165	**Males N=38**	**Females N=127**	**Total N=381**	**Males N=200**	**Females N=181**	**Total N=109**	**Males N=86**	**Females N=23**	
Tobacco N(%)										
Smokers	55 (33.3)	13 (52.0)	42 (49,4)	100(26.2)	53 (36.0)	47 (35.0)	17 (15.6)	12 (16.2)	5 (27.7)	.005
Non Smokers	110(66.7)	25 (48.0)	85 (50.6)	281(73.6)	147(64.0)	134(65.0)	92 (84.4)	74 (83.8)	18 (72.3)	.005
Daily Smokers	40(72.7)	8 (61.5)	32 (76.2)	68(66.7)	41 (75.9)	27 (56.3)	12(66.7)	10 (76.9)	2 (40.0)	.72
Alcohol N(%)										
Consumption last 30 days	101(61.2)	20 (55.6)	81 (62.8)	218(57.7)	119(59.2)	99 (55.9)	65 (59.6)	54 (62.8)	11 (47.8)	.73
5-6 times/week	3 (2.4)	2(7.4)	1(1.0)	4 (1.4)	4(2.5)	0	1 (1.2)	1 (1.5)	0	.810
1-4 times/week	11 (8.7)	2(7.4)	9(9.0)	26 (8.8)	16(9.9)	10(7.5)	11 (13.4)	11 (16.2)	0	
1-3 times/month	61 (48.0)	10(37.0)	51(51.0)	135(45.8)	74(45.7)	61(45.9)	38 (46.3)	29(42.6)	9(64.3)	
< Once/ month	50 (39.4)	11(40.0)	39(39.0)	128(43.4)	67(41.4)	61(45.9)	32 (39.0)	27(39.7)	5(35.7)	
Fruits and vegies Mean	**Total**	**Males**	**Females**	**Total**	**Males**	**Females**	**Total**	**Males**	**Females**	
Fruits/day	1.39	1.5	1.3	1.58	1.4	1.7	1.87	1.9	1.8	.02
Vegies/day	1.01	1.3	.90	1.10	1.0	1.21	1.33	1.4	.98	.18
Fruits + vegies/day	2.44	2.9	2.2	2.65	2.4	2.9	3.16	3.2	2.7	.04

Discussion

Study 1 aimed to identify PA patterns and cross-sectional associations between PA patterns and the adoption of health-related behaviours (alcohol and tobacco consumption, fruit and vegetable intake and sport participation) among adolescents in their last year of compulsory secondary education (16 years of age). The data gathered is helpful to increase awareness about the current situation of teenagers' from Osona concerning their health-related behaviours. Most importantly, this cross-sectional study is the starting point for the oncoming longitudinal research that will allow to investigate the consistency of these associations over time.

The first result of the study indicated that a low percentage of adolescents from Osona do achieve current PA recommendations for health (60 daily minutes of MVPA, WHO, 2010). Low levels of PA and differences between genders on PA levels have been previously described in other countries (Boreham et al., 2004; Haase et al., 2004) including Spain (Gracia-Marco et al., 2011); although, our sample reported a significant lower prevalence of PA. This could have been explained due to the use of self-reported data and, specifically, due to self-evaluation bias (Bailey, 1997). Adolescents might find difficult to remember and specify how many days a week one they achieve 60 minutes of MVPA, especially if the activity is not performed continuously. However, PACE questionnaire was found to have a satisfactory correlation to measure PA in Spanish adolescents (Martínez-Gómez et al., 2009).

The second main result indicated that 78% of females and 42% of males engaged in less than 3 hours a week of sport outside school time. Previous research has shown

that sport participation is likely to contribute to higher levels of PA among youth (Ekelund, Tomkinson, & Armstrong, 2011); with regular participation in organized physical activities and sport competitions being associated to a decreased risk of practising insufficient levels of MVPA (Serrano et al., 2011; Pfeiffer et al., 2006). Compared to previous studies showing a higher prevalence of weekly sport participation among adolescents (Garcia et al., 2011; Nebot et al., 2010), these few hours a week of sport practice identified in hour sample, might have negatively affected MVPA levels among adolescents from Osona, especially females. The low prevalence of sport participation in our sample could be related to specific contextual perceived barriers such as lack of specific facilities, traditionally more prevalent among females ((Slatter & Tiggerman, 2011). Although not included in this PhD thesis, the main perceived barriers for practising sport were also evaluated in the survey, indicating that *"*having others interests*"* (20%) "too much academic work" (17%) and "lack of time" (16%) were the most common barriers.

The third main result indicated that, although similar prevalence of cigarette consumption (25.9%) was found amongst our sample compared to other Catalan and Spanish studies (Tercedor et al., 2007; Departament de Salut, 2013), our results add that a higher level of PA is associated with a lower tobacco consumption. In the low PA group, the percentage of smokers' peak to 33%; on the contrary, in high PA group this percentage was 15.6%. Other studies reinforce the present data reporting a clear negative association between these two behaviours (Kacsynski et al., 2008; Tercedor et al., 2007). Our data contribute to argue that MVPA promotion in adolescence is negatively associated with smoking consumption among 16 years old males and females from Catalonia. The specificity of this age group is important, because no

other studies from Spain focused on 16 years old teenagers were found. Moreover, identifying that tobacco consumption is an unhealthy behaviour spread around 16 years old teenagers from Osona, suggests that on-going efforts in public health should focus on preventing the adoption of this harmful behaviour at this early stage in life (WHO, 2013). Future potential interventions should start with younger kids trying to promote more PA as a protector for cigarette consumption.

The fourth main result indicated that the mean consumption of fruit and vegetable per day among the sample (2.7 units of fruit and vegetable per day) is far to achieve the minimum recommendations: 5 daily servings of fruits and vegetables. The mean consumption encountered in this study is similar to previous European results (Moreno et al., 2014). However, our results indicate positive and significant associations between PA levels and fruits intake. Adolescents from Osona with higher levels of PA tend to eat more fruit (1.9 units per day) compared to medium PA levels (1.6) and low PA levels (1.4). PA levels are, generally related to more fruit and vegetable consumption (McAloney et al., 2014; Ottevaere et al., 2011).

Even though the low PA levels and the low consumption of fruit and vegetable encountered in the sample, it is remarkable that the Body Mass Index (BMI) reached a healthy mean of 21.14 Kg/m^2. Boreham et al. (2004) emphasizes a greater instability in BMI from adolescence to young adulthood; considering that diet and unhealthy lifestyles significantly affect BMI (Kelly, Melnyk, Jacobson, & O'Haver, 2010; Sánchez-Villegas et al., 2003). Future research should study the evolution of the BMI index with the same subjects during the following years in relation with changes in health-related behaviours.

Implications for Public Health

The data gathered by this study contributes towards increasing the knowledge and awareness of teenagers' health-related behaviours within the Catalan context. The low percentage of adolescents achieving the PA recommendations in our sample, reinforce one of the main objectives of the Spanish National Health Plan: To reduce levels of physical inactivity and to make adolescents more aware of the importance to achieve PA recommendations (Ministerio de Sanidad, servicios sociales e igualdad, 2015). Furthermore, our findings indicates that increasing their PA levels among adolescents could also help to achieve other healthy goals such as (i) achieving the daily serving of fruit and vegetable intake during adolescence (Ministerio de Sanidad y Consumo, 2005; Secretaria de Salut Pública, 2013) and (ii) reducing the incidence of consumption of tobacco among Catalan adolescents (Agència de salut pública de Catalunya, 2013). Although the cross-sectional data provided by this study cannot stablish the direction of such relationships, future research should address the directionality of these associations to confirm whether promoting PA in adolescents would also improve the adoption of other health-related behaviours.

Limitations, future directions and conclusions

The current study presents some limitations. Firstly, this is a cross-sectional study which used questionnaires to recollect the data; as a consequence, a cause-effect relationship cannot be established. Secondly, the study used self-report data to determine levels of PA, substance use and fruit and vegetable intake. This might have produced some bias to the final measurements of health-related behaviours. Although a pilot study was carried out for the study, one question remained an issue: Vegetable intake. Despite the images and the explanations of the researcher, a substantial number of teenagers (n=235) could not recount the number of vegetables pieces they eat in a normal day. The final sample size is not big enough to extrapolate the results on a national Catalan basis, although the number is representative to describe the current situation in a specific county of Catalonia (Osona), contributing towards regional public health policies.

Future research

Future longitudinal research is needed to study the stability of the relationships among health-related behaviours and different types of sports and levels of PA across adolescence and beyond. Asking specifically one question about sport participation would help to look for differences between sport practice and PA and, to find associations between type of sport practiced and health related behaviours.

Conclusions of study 1

The low levels of PA observed in the sample (mean age = 16.2 years) is alarming; this data confirms that PA promotion among adolescents in Osona and probably in Catalonia should start at an earlier stage as considered in the national health plans. The present study imply that fruit and vegetable consumption is inadequate among middle age Catalan adolescents, as happen in other industrialised countries with similar means and prevalence (Takaoka & Kawakami, 2013; Pearson et al., 2009; Warnberg et al., 2006). Therefore, the goals set by the WHO regarding these lifestyles, may also be applied in our context. Finally, PA seems to be protective behaviour against some unhealthy habits, like cigarette consumption, and can promote fruit and vegetable intake.

CHAPTER 4.

STUDY 2 -Prospective associations between sport participation, PA levels at leisure time and changes in health related behaviours.

CHAPTER 4. STUDY 2: Prospective associations between sport participation, PA levels at leisure time and changes in health related behaviours.

Overview and purposes

Moving from adolescence to young adulthood is a critical period to adhere to health-related behaviours as adults (Borracci & Mulassi, 2014) and prevent and control the development of chronic diseases among the population (Ferreira et al., 2005). Since (i) the adoption and maintenance of healthy lifestyles diminishes when adolescents move to adulthood (Molina-García et al., 2015), (ii) PA levels significantly drop during this phase across countries -including Spain- (Roman et al., 2006) and, (iii) a decline in a health daily behaviour can facilitate adopting other negative health behaviours ((MacArthur et al., 2012). In this context research is needed to examine how changes to PA and sport participation patterns relate to the adoption of other health-related behaviours. This descriptive longitudinal study will provide a valuable baseline for developing interventions aiming at improving Spanish late adolescents´ healthy behaviours through PA and sport participation.

This study aims (i) to identify levels of PA and sport participation across late adolescents and early adulthood and, (ii) to find associations between PA and sport participation patterns and adherence to health-related behaviours (alcohol and tobacco consumption, fruit and vegetable intake, and sedentary behaviour) in adolescents and early adults from the county of Osona (Barcelona).

Study design and sample

A longitudinal prospective study design was used. Based on the same sample of study 1 (n=695; 342 males, 353 females), the study population were those adolescents that continued with their secondary education school to gain future access to University undergraduate degrees. Adolescents were followed up during three years across their last two years of high school and their first year of University (17, 18 and 19 years of age; Wave 1, 2 and 3 respectively). Changes in PA and lifestyle patterns across late adolescence and young adulthood were tracked. Adolescents were excluded if during the 3 years follow-up period had developed permanent relative/absolute contraindications for practising physical activity (n=1) or decided not to start a University undergraduate degree (n=10).

The longitudinal study was approved by the same Ethics Committee of the University of Vic-Central University of Catalonia as Study 1 (2012). All participants signed a written informed consent before engaging every wave of the longitudinal study.

Survey

The survey aimed to describe participants´ (i) PA levels across different domains (at university, at home, at work, during leisure time, for transportation) (International Physical Activity Questionnaire for Adolescents (IPAQ-A; Kowalski et al., 1997); (ii) Sport participation at leisure time; (Wetton et al., 2013; Kowalski, 2001); (iii) sitting time (Active Where? Survey, Joe & Carlson, 2010). (iv) alcohol and tobacco consumption (FRISC questionnaire, Comin et al., 1997); (v) fruits and vegetables consumption (STEPS instrument, Organizacion Mundial de la Salud (OMS), 2003); and (vi) socio economic and demographic status (gender, age, place of residence, height and weight).

The 42-item questionnaire (appendix 9) was firstly piloted in a convenience sample of 18 year old students from the Vic Basketball Team (n=32; 10 females, 22 males) who voluntarily agreed to test whether the questionnaire was understandable, readable and of manageable length (Shephard, 2003). With a response rate of 56% (n=18), the questionnaires was perceived to be reasonably understandable (88%), readable (88%) although it was perceived to be a bit too long (41%) (appendices 10 and 11).

Variables measured and questionnaire used

A detailed description of variables and measurements for tobacco, alcohol and fruit and vegetable consumption has been described in Study 1. Briefly, alcohol consumption was measured by asking alcohol consumption during the last month and units of alcohol taken monthly (FRISC questionnaire; Comin et al., 1997). Considering that underage should consume no alcohol at all (Mack, 2010) and knowing that adolescents who drink weekly may present serious health related problems (Ministerio de Sanidad y Consumo, 2007), the present study will divide between: i) ≥ 1 drink a week consumers or ii) < 1 drink a week consumers, to find associations between regular alcohol consumption and sport participation. Tobacco consumption was measured by identifying current smoking status (Smoker/Non smoker) and number of daily cigarettes if being a current smoker (FRISC questionnaire; Comin et al., 1997). Fruit and vegetable consumption was measured in daily servings using the Spanish version of the STEPS instrument (Organizacion Mundial de la Salud-OMS, 2003) in order to identify achievement of the current recommendation for health (5 servings/day; WHO, 2004) and associated with sport participation.

Physical activity in different domains

The IPAQ-A long form is a self-administrated, 7 day-recall instrument especially validated for adolescents (Hagströmer et al., 2008). It is a 25-item questionnaire that reports frequency, intensity and duration of PA in four different domains: work,

transport, house and leisure time. It shows reasonable validity properties for assessing activities in different intensities and for total physical activity in healthy European adolescents aged 15–17 years (ICC=0.17-0.30, p<.005) (Hagströmer et al., 2008); with good Spearman's reliability correlation (p = 0.80) between countries (Craig et al., 2003). The IPAQ-A long form demonstrated sensitivity to detecting changes overtime (Porchaska et al., 2008), and therefore, it was appropriate for longitudinal studies. For the present study, we obtained the Spanish version of the IPAQ-A, which has been used by the HELENA study (Healthy Lifestyle in Europe by Nutrition in Adolescence), (Hagströmer et al., 2008; Ottevaere et al., 2011). The long version of the IPAQ showed a good reliability coefficient for total PA (r=0.82, P<0.05), vigorous activity (r=0.79, P<0.05), moderate activity (r=0.83, P<0.05), and time spent walking (r=0.73, P<0.05) in Spanish population (Roman-Viñas et al., 2010).

All cases in which the sum total of all walking, moderate and vigorous time variables was greater than 960 minutes (16 hours) was excluded from the analysis, as indicated in the IPAQ guidelines (Kowalski et al., 1997). Moreover, PA scores were truncated in the different domains (school: max 1800 min/week or about 4 hr/day; home: max 1680 min/week or 4 hr/day; transport: max 1290 min/week or 3 hr/day; leisure time: max 1680 min/week or 4 hr/day; total PA: max 2540 min/week or about 6 hr/day) as well as in the different intensity levels (max 1260 min/week or 3 hr/ day for moderate and vigorous PA) as specified by previous adolescents' research (Ottevaere et al., 2011). Thereafter, we calculated total score for the 4 main domains presents in the IPAQ-A: school, transport, house and leisure time; this data is reported as comparisons of median values. IPAQ-A provides a continuous measure of PA in total MET-minute/week, with the following formulas:

Walking MET-minutes/week = 3.3 * walking minutes * walking days.

Moderate MET-minutes/week = 4.0 * moderate-intensity activity minutes * moderate-intensity days.

Vigorous MET-minutes/week leisure = 8.0 * vigorous-intensity activity minutes * vigorous-intensity days.

Total MET-minutes/week = sum of Walking + Moderate + Vigorous MET-minutes/week scores.

For the present study we classified the participants considering their PA levels during leisure time noted in IPAQ-A. Insufficient PA was defined as less than 300 minutes per week of moderate- to vigorous-intensity PA practice during leisure time, in accordance with previous research and current PA guidelines for adolescents (Dumith et al., 2010; Bastos, Araújo, & Hallal, 2008; Hallal et al., 2006; Biddle, Cavill, & Sallis, 1998; Guthold et al., 2010). This threshold has been previously used on Spanish research looking for associations between screen time and PA among Spanish adolescents (Serrano-Sánchez et al., 2011).Three hundred minutes/week of PA during leisure time has been proved having great benefits for health in both adolescents and adults (Sattelmair et al., 2011). The analysis was focused on PA during leisure time for two main reasons; firstly, PA at leisure time is equivalent to sport participation, due to both activities are performed at leisure; secondly using only one IPAQ domain we excluded overestimation through the 4 domains, a common problem when analyzing IPAQ (Rzewnicki, Auweele, & Bourdeaudhuij, 2003; Hallal et al., 2010) and we also minimize the problematic of overestimation among children and adolescents surveys (a systematic review found that 72% of the indirect measures among people aged ≤19 years overestimated the directly measured values) (Adamo et al., 2009). Finally, PA at

leisure has been previously used in Spanish and Catalan national surveys to differentiate between active and inactive individuals (Ministerio de Sanidad, Servicios Sociales e Igualdad, 2013; Departament de Salut, 2015).

Sport participation

Sport participation and type of sport were asked using a specific and concrete question based on previous adolescent research (Wetton et al., 2013; Kowalski, 2001). The questions asked for this variable were: (i) *Do you currently practice any sport? (ii) In case you do, which sport do you practice?* Prior to the questions, sport participation was appropriately defined, taking into account the previous used definition (WHO, 2010) as "a type of physical activity performed periodically and within a set of rules, and undertaken as part of leisure or competition".

The scoring system for sport participation consisted of classifying teenagers in (i) sport participants (answering "Yes" to the first question) or (ii) non-sport participants (answering "No" to the first question). Amongst the sporty group, participants were identified as practicing either team or individual sport by answering what type of sport they practice. This classification was conducted because playing individual or team sport has previously shown different associations with lifestyle behaviours (Terry-McElarth et al., 2011; Lorente et al., 2004).

Taking into account sport participation and PA at leisure time (IPAQ-A) , four groups of participants were identified across waves 1, 2 and 3 which reflected the most prevalent changes in PA and sport patterns from late adolescence to young adulthood: Team sport participants (TS), Individual sport participants (IS), Non-sport participants

but physically active (NSA; Non-sport participants doing ≥300 minutes of leisure time PA a week) and Non-sport participants and physically inactive (NSI; Non-sport participants doing ≤300 minutes of leisure time PA a week).

Sitting time

Sitting time was measured using the Active Where? Survey (Joe & Carlson, 2010). Twenty three items assessed the amount of time spent during sedentary activities (educational, leisure, transport and others) in weekdays and weekends. It is based on a seven point scale, with answers ranging from none to 5 hours or more (No; 15 min; 30 min; 1 hour; 2 hours; 3 hours; 4 hours; 5 hours or + (specify how many hours)). Moderate to high test-retest reliability for sedentary activities at leisure time has been shown in most sitting domains: TV viewing (weekday ICC=.654, weekend ICC=.527), playing video games (weekday ICC=.552, weekend ICC=.501) and computer use (weekday ICC=.649, weekend ICC=.641); showing a percentage of agreement over 43% with the same questionnaire conducted twice (Joe & Carlson, 2010). Time spent sitting during educational activities such as doing homework (weekday ICC= .511, weekend ICC=.642) and sitting at work/school (weekday ICC=.345, weekend ICC=.711) also presented a good reliability (Joe & Carlson, 2010). The reliability for other sedentary behaviors was: sitting and talking with friends/family (weekday ICC=.327, weekend ICC=.446), reading a book or magazine not for school (weekday ICC=.492, weekend ICC=.489) and doing inactive hobbies (weekday ICC=.319, weekend ICC=.300). For transport, reliability for time spent riding or driving in a car for weekdays was ICC=.456 and for the weekend was ICC=.511; with a percentage of agreement ranging from

30.3% compared to doing inactive hobbies during the weekends to 73.3% compared to sitting at work/school during the weekend (Joe & Carlson, 2010).

When analyzing sedentary behavior, total daily minutes of sitting time were counted by using the following calculation: [(minutes of sitting time weekday * 5 + minutes of sitting time weekend *2) / 7] as used in previous research (Thorp et al., 2009). This calculation resulted in the daily mean of minutes that adolescents spent sitting through the week. Furthermore, total sitting time in a normal weekday and total sitting time during a weekend day were calculated to compare differences between weekdays and weekend days. The same calculation was applied to the four different sitting time domains: 1) Total leisure screen time: TV viewing, video games and computer for leisure; 2) sitting for educational reasons: doing homework and sitting at work/school; 3) other hobbies: sitting and talking with friends/family, reading a book or magazine not for school and doing inactive hobbies; 4) Transport time: riding or driving in a car. It is important to clarify that two items of the questionnaire (sitting listening to music and sitting talking on the telephone or texting) were not included in the final analysis for two main reasons. Firstly, adolescents from the pilot study identified these two activities were usually performed at the same time than other activities that were already been measured (i.e. talking with friends or using the computer). Secondly, when doing the analysis we could observe that if we add these two items to the final sitting time the numbers were unreasonably high (≥ 600 minutes a day).

Demographic information

Demographic information (date of birth, gender, height and weight) were measured using the same questions than study 1. Mean age and body Mass Index (BMI) (Mass (Kg)/Height $(m)^2$) were calculated.

Data Collection

The Department of Education in Osona endorsed the study and provided the complete list of schools that offered high school education (n=16) in the county at 2012. These schools were spread around twelve different towns including: Vic (n=6), Torelló (n=1), Tona (n=2), Manlleu (n=2), Centelles (n=1), Massies de Voltregà (n=1), Prats de Lluçanès (n=1), Roda de Ter (n=1) and Taradell (n=1) (appendix 12). Student´s contact details (email address and telephone number) were voluntarily provided from study 1. Our potential sample were all participants from study 1 (n=664).

Wave 1 and 2 of the longitudinal study

During the first and second year of the longitudinal study (Wave 1, 2012- Wave 2, 2013), an email was sent to directors of each high education school (n=16) requesting permission for their 17^{th} years old students to complete a follow-up survey as part of the study initiated in study 1 (2012). Twelve high schools accepted to participate in the study (appendix 13). Detailed information about the longitudinal study and the written informed consent form designed for students was provided to each director. An

individual year-by-year approach was taken as directors believed permission needed to be requested for every year of the longitudinal study. Once directors´ verbal consent was obtained, the same procedure as study 1 was used to gather data from questionnaires during waves 1 and 2 of the longitudinal study (17 and 18 years of age). The surveys were conducted during January-May 2012 and January-May 2013 respectively. All adolescents that completed the survey in each wave were awarded with rubber bracelets specially made and designed for the project as well as discount vouchers, that along with an Identification card showing the membership to the project (GEN95), provided participants with 50% discounts on clothes shops, restaurants and concert tickets (appendix 14).

Wave 3 of the longitudinal study

During September-December 2014, a Web site for the project called Uzona*Gen95 (*http://gen95.uvic.cat), Facebook (uzonagen95), an email account (uzonagen95@gmail.com), posters and bracelets were created to make the project more visible (appendices 14 and 15) and gain access to participants during Wave 3 (when participants could go to any University in Catalonia, Spain or abroad). The Website included detailed information of the project as well as the online survey – which used the Survey Monkey data base system (www.surveymonkey.com)- in order to provide easy access to the questionnaire from any University around Catalonia, Spain or internationally. The website also contained cultural activities such as concerts, theatre and expositions happening in the county of Osona with new activities being weekly displayed. The aim of the Website were to (i) create a meeting point for

participants, (ii) provide updated information about the project and (iii) provide a platform to gather online data during Wave 3.

During January-May 2014 (Wave 3), the 19 years old students were invited to fill in the survey by either contacting them through personal email, Facebook or through advertisements on the project Website. The email reminded them about the aims of the study, informed them about previous results (appendix 16) and invited them to download the informed consent form and the questionnaire from the Web Site of the project (http://gen95.uvic.cat). Messages to personal Facebook accounts included information about the advantages to fill up the questionnaire (awards, raffles and vouchers) and the usefulness and benefits of this research. A reminder email was sent every two weeks during two months to maximise response rate (from February to April 2014). Messages to personal Facebooks accounts were additionally sent to participants when the personal email was not known or had not responded to remainders.

Firstly, participants completed the informed consent from the webpage. Then, an automatic email was sent to their personal email account which included a link to the survey. After completing the questionnaire, participants wrote a postal address where to receive twenty *UVic Vouchers* in order to get 50% discounts in several shops, restaurants and concert tickets offered in Osona. In addition, three free dinners in restaurants at the city of Vic were raffled among participants who had filled in the survey. Discount vouchers were sent through postal mails to avoid digital copies of the vouchers. Of a potential sample of 695 teenagers (from Study 1); 688 participants responded to Wave 1 (98% response rate), 430 adolescents responded to Wave 2 (61% response rate) and 181 participants responded to Wave 3 of the longitudinal study

(26% response rate). During Wave 1, twelve out of 16 high secondary schools from Osona agreed to participate in the study. Reasons for non-participation were lack of time and/or availability. During Wave 2, ten out of the 12 schools surveyed during the last year, participated in the study. The two remaining schools did not answer to our emails and phone calls asking for their participation. During Wave 3, participants had to fill up the online survey (http://gen95.uvic.cat).

Statistical Analysis

Data cleaning for each variable was repeated in the same way as study 1 (Van den Broeck et al., 2005). General descriptive statistics (frequencies and descriptive) for BMI, PA levels, sport participation, alcohol, tobacco, fruit and vegetable consumption and sedentary time were computed. Chi-Square test was used to examine differences on PA, sport participation and other health-related behaviour patterns between females and males across the longitudinal study. Cross-tabulations were used to analyse the relationship between the four subgroups in PA/sport participation patterns and the other health-related behaviours across Waves 1, 2 and 3. For BMI, sitting time, fruit and vegetable consumption, a Kruskal-Wallis test was used to identify any relationships between levels of PA/sport participation subgroups across Waves. A p-value ≤ 0.05 was considered to be statistically significant. The analysis was performed using SPSS statistics 21.

Results

A final sample of 662 adolescents (345 females, 317 males) completed the questionnaire in Wave 1 (2012), 411 adolescents (217 females, 194 males) completed it in Wave 2 (2013) and, 180 adolescents (100 females, 80 males) completed it in Wave 3 (2014). Response rates of the questionnaires handed were 96%, 95% and 99% respectively. Descriptive characteristics concerning BMI, PA and sport patterns, lifestyle behaviours (tobacco consumption, alcohol consumption and fruit and vegetable intake) and total sedentary time across all waves (Table 8).

Physical activity and sport participation patterns during the 3 follow-up period

Cross-sectional data on the means and prevalence of BMI, PA scores, lifestyle behaviours (alcohol, tobacco, fruit and vegetables) and sedentary behaviours are shown in table 8. Both genders reported increasing of BMI means showing significant differences (p. ≤.001) between genders across the years. However, BMI values remain into the normal weight range all the waves (WHO, 2000). Total PA is significantly higher among males compared to females in 2012, 2013 and 2014. Total PA levels increase in both genders from 2012 to 2014, mainly reflected in an increase of the amount of METs spent at home and school/work. The most significant differences (p. ≤.001) in all the waves between genders occur when observing PA levels during leisure time. PA at leisure is higher in males compared to females (+833 Mets/hour/week), and remarkably reduce among females across waves (-410 METs/hour/week). Males significantly play more sport than females (p. ≤.001) in all the studied years, being

team sport more popular among males and individual sports more popular amongst females. Type of sport practiced in waves 1 and 2 are detailed below (figure 1 and 2).

Other health-related behaviours patterns during the 3 years follow-up period

The amount of smokers was significantly higher in males compared to females when they were 16-17 years old (38.9% Vs 30.1%; X^2=5.63, p.=.01). Through the years these differences diminished (35.0% of males and to 32.0% of females) and became non-significant. Alcohol consumption during the last 30 days was common among 16 to 17 years old males and females (82.9% and 78.3% respectively) and remained high across the years, with non-significant differences between genders. Frequency of consumption (1 or more drinks a week) was significantly higher in males than in females in the first two waves ($p \leq .05$). The mean consumption of daily fruit and vegetable was below the recommendation at the beginning of the study for males (3.6) and for females (3.9); moreover this daily servings of fruits and vegetables was even lower in 2014 (3.3 for males and females). No significant differences were observed between genders. Total sitting time remains over 646 min/day in all the studied years, females sitting more time than males with significant differences between genders (p.≤.05). Screen time is more prevalent among males than females with significant differences in the first two waves (p.≤.05). Minutes of passive transport and doing sedentary hobbies increases and minutes of sitting in class decrease in the last year of the study, compared to the previous waves (Table 8). Subsequently, descriptive data for sport participation in wave 1 and wave 2 are presented in figure 1 and 2. Males and females are analysed separately due to significant gender differences on sport participation ($p \leq .05$).

Table 8. *Descriptive results regarding PA, sport participation, BMI, lifestyles and sitting time for males and females across study waves.*

	2012 (Wave 1)			2013 (Wave 2)			2014 (Wave 3)		
	Total N=662	**Males N=317**	**Females N=345**	**Total N=411**	**Males N=194**	**Females N=217**	**Total N=180**	**Males N=80**	**Females N=100**
BMI (Kg/m²)									
BMI Mean(SD)	21.15 (2.56)	21.93 (2,68)	20.43 (2.21)	21.32 (2.64)	22.22 (2.52)	20.48 (2.46)	21.66 (2.73)	22.37 (2.58)	21.13 (2.73)
Physical Activity METs-min/week Mean(SD)									
PA at school	1222 (1105)	1394 (1230)	1064 (951)	1820 (3476)	2230 (4562)	1453 (2012)	1602 (2568)	1831 (3094)	1434 (2065)
PA for transport	580 (609)	622 (695)	542 (515)	624 (716)	646 (772)	604 (663)	608 (548)	508 (376)	688 (646)
PA at home	628 (647)	656 (660)	602 (635)	801 (1028)	786 (1103)	815 (959)	897 (896)	981 (978)	826 (828)
PA at leisure	1860 (1530)	2194 (1640)	1554 (1353)	1938 (1782)	2468 (1896)	1465 (1552)	1525 (1596)	2000 (1913)	1144 (1175)
Total PA	4292 (2371)	4868 (2488)	3763 (2128)	5185 (4686)	6133 (5625)	4338 (3473)	4634 (3549)	5320 (4096)	4096 (2972)
Sport practice N(%)									
No sport practice	290 (43.8)	91 (28.8)	199 (57.6)	191 (46.5)	57 (29.4)	134 (61.8)	101 (55.8)	34 (42.5)	67 (67.0)
Sport Practice	372 (56.2	221 (71.3)	146 (42.3)	220 (53.5)	137 (70.6)	83 (38.2)	79 (44.2)	46 (57.5)	33 (33.0)
Team sport participants	225 (34.0)	164 (51.7)	61 (17.7)	135 (32.8)	97 (50.0)	38 (17.5)	47 (26.1)	31 (38.8)	16 (16.0)
Individual sport participants	147 (22.2)	62 (19.6)	85 (24.6)	85 (20.7)	40 (20.6)	45 (20.7)	32 (17.8)	15 (18.8)	17 (17.0)
Tobacco use									
Current smokers N(%)	227 (34.3)	123 (38.9)	104 (30.1)	137 (33.3)	61 (31.4)	76 (35.0)	60 (33.7)	28 (35.0)	32 (32.0)
Non-smokers N(%)	434 (65.6)	193 (61.1)	241 (69.9)	274 (66.7)	133 (68.6)	141 (65.0)	120 (66.3)	52 (65.0)	68 (68.0)
Nº daily cigarettes Mean(SD)	5.2 (4.8)	4.6 (4.67)	5.7 (4.8)	4.3 (3.9)	3.7 (4.1)	4.7 (3.7)	3.4 (3.7)	4.1 (4.5)	2.8 (2.8)
Alcohol intake N(%)									
Alcohol consumption	532 (80.4)	262 (82.9)	270 (78.3)	344 (83.7)	159 (82.0)	185 (85.3)	146 (81.2)	66 (82.5)	80 (80.0)
Alcohol non-consumption	129 (19.5)	54 (17.1)	75 (21.7)	67 (16.3)	35 (18.0)	32 (14.7)	34 (18.8)	14 (17.5)	20 (20.0)
Every day	3 (0.6)	2 (0.8)	1 (0.4)	5 (1.4)	3 (1.9)	2 (1.1)	0	0	0
5-6 times a week	11 (2.1)	10 (3.8)	1 (0.4)	9 (2.6)	6 (3.8)	3 (1.6)	2 (1.4)	1 (1.5)	1 (1.2)
1-4 times a week	96 (18.0)	66 (25.0)	30 (11.1)	71 (20.6)	49 (30.8)	22 (11.8)	42 (28.6)	22 (33.3)	20 (24.7)
1-3 times a month	322(60.3	148(56.1)	174(64.4)	213(61.7)	82 (51.6)	131(70.4)	84 (57.1)	39 (59.1)	45 (55.6)
<once a month	101(18.9	37 (14.0)	64 (23.7)	47 (13.6)	19 (11.9)	28 (15.1)	19 (12.9)	4 (6.1)	15 (18.5)

	2012 (Wave 1)			2013 (Wave 2)			2014 (Wave 3)		
	Total N=662	**Males N=317**	**Females N=345**	**Total N=662**	**Males N=317**	**Females N=345**	**Total N=662**	**Males N=317**	**Females N=345**
Fruit and Vegies									
Fruits per day Mean(SD)	2.0 (1.23)	1.9 (.1.21)	2.1 (1.25)	1.9 (1.17)	1.9 (1.16)	1.6 (1.04)	1.6 (1.2)	1.7 (1.15)	1.6 (1.25)
Vegetables per day Mean(SD)	1.8 (1.11)	1.7 (1.09)	1.8 (1.13)	1.7 (1.03)	1.9 (1.19)	1.7 (1.02)	1.6 (1.1)	1.6 (1.17)	1.7 (1.16)
Fruit & vegetable per day Mean(SD)	3.8 (1.97)	3,6 (1,96)	3,9 (1.98)	3.6 (1.83)	3.6 (1.82)	3.6 (1.84)	3.3 (2.05)	3.3 (2.03)	3.3 (2.09)
<5 per day N(%)	441 (66.9)	218 (69.4)	223 (64.6)	301 (73.2)	144 (74.2)	157 (72.4)	133 (73.9)	59 (73.8)	74 (74.0)
≥5 per day N(%)	218 (33.1)	96 (30.6)	122 (35.4)	110 (26.8)	50 (25.8)	60 (27.6)	47 (26.1)	21 (26.3)	26 (26.0)
Sedentary time Minutes per day Mean(SD)									
Total sitting time;	732 (270)	736 (268)	728 (250)	683 (280)	678 (214)	685 (236)	672 (259)	646 (260)	692 (266)
Screen time	228 (126)	252 (123)	205 (124)	189 (103)	207 (107)	172 (96)	196 (123)	209 (133)	187 (114)
Sitting for transport	26 (38)	23 (35)	29 (41)	26 (36)	22 (34)	30 (37)	60 (57)	57 (53)	61 (59)
Other hobbies*	125 (91)	106 (85)	143 (93)	120 (102)	102 (76)	135 (83)	170 (122)	138 (82)	194 (142)
Sitting in class (weekday)	353 (50)	355 (48)	351 (52)	348 (44)	347 (39)	348 (47)	246 (106)	242 (105)	250 (108)

*Other hobbies: Reading, musical instruments, talking with friends, cinema and art crafts.

Figure 1. *Type of sports practiced amongst males in waves 1 and . (n = 317)*

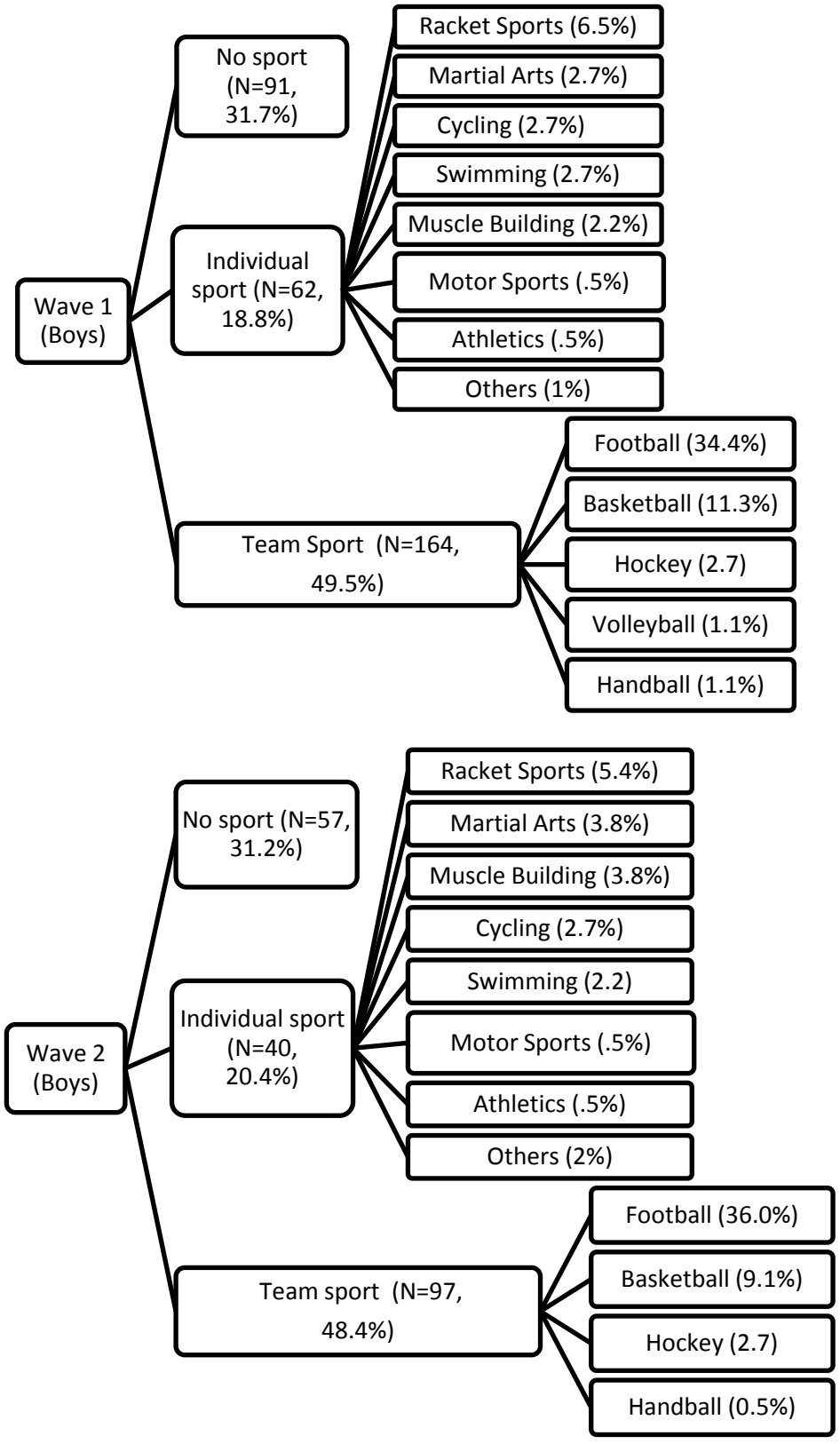
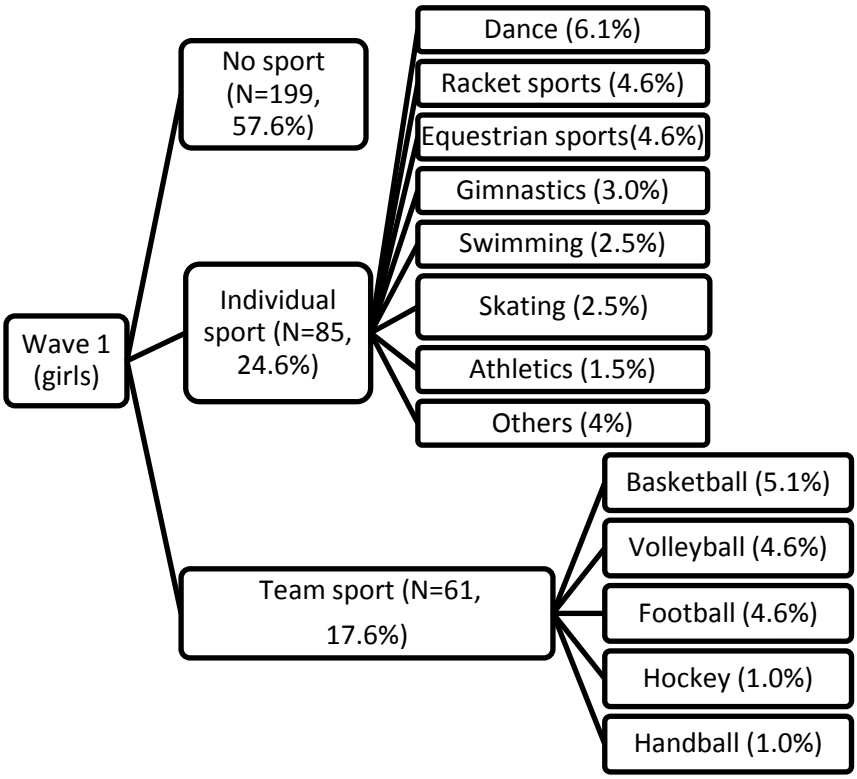
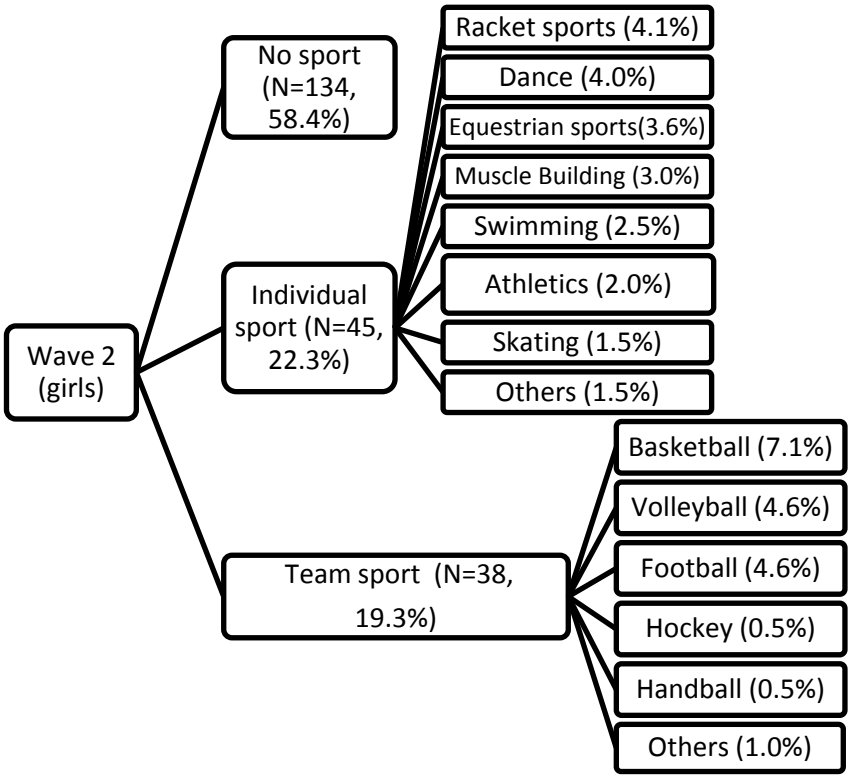


Figure 2. *Type of sports practiced amongst females in waves 1 and 2 (n = 345).*





Associations between sport participation and achievement of current PA recommendations from adolescence to young adulthood

In all the studied years those involved in sport were significantly (p <.001) more likely to meet the criteria to be defined as active. The majority of those not involved in sport were inactive; there was a proportion of non-sport participants that reported being physically active (35% in 2012; 28% in 2013 and 12% in 2014). The average proportion of teenagers meeting the required level to be considered active during the first two waves was 67%. At wave 3 the number of active individuals decreased in both groups of participants who were originally defined as involved or not involved in sports. However, at this time 57% of the sport participants still met the requirements for being defined as active (Table 9).

Table 9. *Associations between sport participation and achievement of current PA recommendations from late adolescence to young adulthood*

	2012 (Wave 1)			**2013 (Wave 2)**			**2014 (Wave 3)**		
	Physical Activity			**Physical Activity**			**Physical Activity**		
	Active	**Inactive**	**p. value**	**Active**	**Inactive**	**P. value**	**Active**	**Inactive**	**p. value**
Sport participation N(%)									
Team sport	166 (73.8)	59 (26.2)	<.001	95 (70.4)	40 (29.6)	<.001	28 (58.3)	20 (41.7)	<.001
Ind. Sport	94 (63.9)	53 (36.1)	<.001	54 (63.5)	31 (36.5)	<.001	18 (56.3)	14 (43.8)	<.001
No Sport	103 (35.5)	187 (64.5)	<.001	53 (27.7)	138 (72.3)	<.001	12 (11.9)	89 (88.1)	<.001

Relationships between subgroups of sport participation and achievers of current PA recommendations with specific domains of PA from adolescence to young adulthood

Total PA levels are different at all waves for both males and females, presenting significant differences between subgroups of sport participation ($p \leq .01$) in all the waves (Tables 10 and 11). The main difference in PA between males and females is in the amount of leisure time activity across all the waves ($p < .001$). For males and females across all the waves significant differences were observed between the NSI compared to the TS, IS and NSA group in this specific domain. As expected the MET values at school/work increased in wave 3 in both genders. Non-sportiest and inactive are, also, the ones spending fewer METs a week when adding all the IPAQ domains, with significant differences between groups for males and females in all the waves ($p < .01$) (tables 10 and 11). METs spend at work/school increased over time in nearly all the subgroups, which provokes a general increase of the total METs across the years. However, the association between subgroups of sport and PA levels at work/school need to be look carefully due to lack of significant differences in all the waves and especially because the high SD values might affect the final results (Tables 10 and 11).

Table 10. *Relationship between males' subgroups of sport participation with the specific domains of PA.*

	2012 (Wave 1)					2013 (Wave 2)					2014 (Wave 3)				
	NSI (N=36)	**NSA (N=55)**	**TS (N=164)**	**IS (N=62)**	**p.**	**NSI (N=29)**	**NSA (N=28)**	**TS (N=97)**	**IS (N=40)**	**p.**	**NSI (N=28)**	**NSA (N=6)**	**TS (N=31)**	**IS (N=16)**	**p.**
Physical Activity METS-Minute/week Mean(SD)															
PA at Work	576 (556)	1962 (1260)	1362 (1199)	1451 (1314)	<.001	1541 (1749)	3782 (1450)	1872 (2376)	2514 (2968)	.696	1450 (1947)	2590 (4936)	2609 (3849)	629 (1686)	.102
PA for Transport	496 (370)	853 (713)	530 (570)	733 (1005)	.001	435 (433)	645 (575)	711 (882)	643 (790)	.567	563 (451)	446 (132)	504 (381)	437 (278)	.957
PA at Home	297 (394)	1100 (813)	612 (601)	588 (592)	<.001	966 (2054)	1001 (803)	698 (736)	719 (1063)	.085	616 (721)	1553 (942)	1190 (1052)	1002 (1097)	.045
PA at Leisure	603 (735)	2335 (1736)	2354 (1490)	2569 (1819)	<.001	611 (672)	2574 (1089)	2836 (2002)	2849 (1929)	<.001	867 (1043)	2909 (1793)	1963 (1246)	3826 (2754)	<.001
Total PA levels	1972 (830)	6252 (1974)	4859 (2268)	5343 (2751)	<.001	3555 (3246)	8003 (3613)	6119 (4317)	6726 (4164)	.001	3498 (2663)	7500 (5216)	6266 (4623)	5896 (3805)	.01

Table 11. *Relationships between females' subgroups of sport participation with the specific domains of PA*

	2012 (Wave 1)					2013 (Wave 2)					2014 (Wave 3)				
Physical Activity METS-Minute/week Mean(SD)	**NSI (N=85)**	**NSA (N=114)**	**TS (N=61)**	**IS (N=85)**	**p. value**	**NSI (N=103)**	**NSA (N=31)**	**TS (N=38)**	**IS (N=45)**	**p. value**	**NSI (N=64)**	**NSA (N=3)**	**TS (N=16)**	**IS (N=17)**	**p. value**
PA at Work	461 (445)	1421 (980)	1369 (1145)	970 (812)	<.001	1037 (1704)	2592 (2540)	1946 (2323)	1202 (1616)	.003	1008 (1317)	936 (1163)	1497 (1907)	3067 (3515)	.125
PA for Transport	353 (291)	651 (550)	543 (514)	585 (594)	<.001	476 (408)	986 (1144)	557 (529)	672 (703)	.025	724 (708)	506 (462)	632 (539)	635 (545)	.865
PA at Home	331 (337)	921 (794)	468 (514)	540 (522)	<.001	686 (809)	1403 (1568)	835 (824)	685 (669)	.020	852 (923)	640 (660)	709 (724)	875 (563)	.643
PA at Leisure	458 (520)	1490 (1231)	2245 (1299)	2240 (1392)	<.001	482 (468)	2507 (1560)	2214 (1677)	2363 (1720)	<.001	744 (815)	3092 (667)	1267 (956)	2192 (1575)	<.001
Total PA levels	1604 (655)	4485 (1622)	4626 (2137)	4336 (2240)	<.001	2684 (2102)	7490 (5262)	5554 (3003)	4924 (2734)	<.001	3329 (2079)	5174 (2076)	4107 (2149)	6771 (4752)	.006

Relationships between subgroups of sport participation with health-related behaviours among males from late adolescence to young adulthood

Males doing team sport present higher prevalence of tobacco consumption compared to other groups, showing significant differences in wave 2 (X^2=13.29; p .004) (table 11). Similarly, alcohol consumption is higher in TS with significant differences between groups in wave 1 (X^2=15.84; p .001) and wave 2 (X^2=11.63; p .009). Frequency of alcohol consumption (≥ one drink per week) is generally higher among non-sportiest males, however the differences between groups are non-significant (p >.05). Adolescent' males who play one sport have a tendency to reach more frequently the minimum recommendations of fruit and vegetables consumption (≥5 fruits and vegetables a day). Although the differences between groups are not significant (p >.05), those adolescents doing an individual sport reach more frequently the minimum fruit and vegetable intake (Table 12).

Table 12. *BMI and lifestyle behaviours associated with subgroups of sport participation among males.*

	2012 (Wave 1)						2013 (Wave 2)						2014 (wave 3)					
	NSI N=36	**NSA** N=55	**TS** N=164	**IS** N=62	**Total** N=317	**p. value**	**NSI** N=29	**NSA** N=28	**TS** N=97	**IS** N=40	**Total** N=194	**p. value**	**NSI** N=28	**NSA** N=6	**TS** N=31	**IS** N=15	**Total** N=80	**p. value**
Tobacco Use																		
Smoker N(%)	12 (33.3)	20 (37.0)	73 (44.5)	18 (29.0)	123 (38.9)	.15	7 (24.1)	4 (14.3)	42 (43.3)	8 (20.0)	61 (31.4)	.004	10 (35.7)	2 (33.3)	13 (41.9)	3 (20.0)	28 (35.0)	.54
No smoker N(%)	24 (66.7)	34 (63.0)	91 (55.5)	44 (71.0)	193 (61.1)		22 (75.9)	24 (85.7)	55 (56.7)	32 (80.0)	133 (68.6)		18 (64.3)	4 (66.7)	18 (58.1)	12 (80.0)	52 (65.0)	
Cigarettes per day Mean(SD)	5.9 (5.7)	5.6 (5.4)	4.2 (4.4)	4.7 (4.2)		.46	3.2 (1.3)	2.0 (1.8)	3.9 (4.8)	3.2 (3.3)		.63	3.8 (4.7)	7.5 (3.5)	2 (3.1)	7.6 (5.6)		.14
Alcohol Use N(%)																		
Alcohol Use*	22 (61.1)	44 (80.0)	144 (88.3)	52 (83.9)	262 (82.9)	.001	23 (79.3)	17 (60.7)	86 (88.7)	33 (82.5)	159 (82.0)	.009	21 (75.0)	6 (100)	27 (87.1)	12 (80.0)	66 (82.5)	.410
Alcohol non-use	14 (38.9)	11 (20.0)	19 (11.7)	10 (16.1)	54 (17.1)		6 (20.7)	11 (39.3)	11 (11.3)	7 (17.5)	35 (18.0)		7 (25.0)	0 (0)	4 (12.9)	3 (20.0)	14 (17.5)	
≥ 1 drink per week	17 (73.9)	29 (64.5)	100 (69.4)	39 (75.0)	185 (70.1)	.64	15 (65.2)	15 (88.2)	51 (59.3)	20 (60.6)	101 (63.5)	.46	16 (76.3)	5 (83.3)	14 (51.8)	8 (66.7)	43 (65.2)	.270
≤ 1 drink per week	6 (26.1)	15 (35.5)	44 (30.6)	13 (25.0)	79 (29.9)		8 (34.8)	2 (11.8)	35 (40.7)	13 (39.4)	58 (36.5)		5 (23.8)	1 (16.7)	13 (48.1)	4 (33.3)	23 (34.8)	
Fruit and Vegies**																		
<5 per day N(%)	29 (82.9)	38 (69.1)	112 (68.7)	39 (63.9)	218 (69.4)	.27	24 (82.8)	23 (82.0)	73 (75.3)	24 (60.0)	144 (74.2)	.09	23 (82.1)	3 (50.0)	24 (77.4)	9 (60.0)	59 (73.8)	.21
≥5 per day N(%)	6 (17.1)	17 (30.9)	51 (31.3)	22 (36.1)	96 (30.6)		5 (17.2)	5 (17.9)	24 (24.7)	16 (40.0)	50 (25.8)		5 (17.9)	3 (50.0)	7 (22.6)	6 (40.0)	21 (26.3)	

*Alcohol consumption during the last 30 days. **Fruits and Vegetables consumption per day

Relationships between subgroups of sport participation with health-related behaviours among females from late adolescence to young adulthood

On the one hand, alcohol consumption is significantly more prevalent in wave 1 (X^2=8.63; p .001) and wave 2 (X^2=7.82; p .05) among those females doing one sport, either individual or team sports. On the other hand, similarly to what happen with males, females who are more active during leisure time (NSA, TS or IS) lean towards eating more fruits and vegetables than their non-sportiest and sedentary colleagues. The difference is significant in the first year of the study (wave 1) (X^2=10.04; p .001) (table 13). Finally, although NSI females are the ones with higher prevalence of tobacco consumption, and consuming more cigarettes a day in wave 1, the differences between groups are not significant (p >.05) (Table 13).

Table 13. *BMI and lifestyle behaviours associated with subgroups of sport participation among females.*

	2012						2013						2014					
	NSI N=85	**NSA** N=114	**TS** N=61	**IS** N=85	**Total** N=345	**p. value**	**NSI** N=103	**NSA** N=31	**TS** N=38	**IS** N=45	**Total** N=217	**p. value**	**NSI** N=64	**NSA** N=3	**TS** N=16	**IS** N=17	**Total** N=100	**p. value**
Tobacco Use																		
Smoker N(%)	29 (34.1)	34 (29.8)	18 (29.5)	23 (27.1)	104 (30.1)	.79	38 (36.9)	11 (35.5)	13 (34.2)	14 (31.1)	76 (35.0)	.92	24 (37.5)	0 (0)	4 (25.0)	4 (23.5)	32 (32.0)	.35
No smoker N(%)	56 (65.9)	80 (70.2)	43 (70.5)	62 (72.9)	241 (69.9)		65 (63.1)	20 (64.5)	25 (65.8)	31 (68.9)	141 (65.0)		40 (62.5)	3 (100)	12 (75.0)	13 (76.5)	68 (68.0)	
Cigarettes per day Mean(SD)	6.81 (7.2)	5.4 (4.8)	4.8 (2.4)	5.2 (3.7)		.58	4.0 (3.0)	8.0 (6.4)	3.9 (.70)	4.9 (3.2)		.63	2.7 (2.3)	0 (0)	.75 (.50)	5.2 (4.2)		.97
Alcohol Use N(%)																		
Alcohol Use*	64 (75.3)	81 (71.1)	53 (86.9)	72 (84.7)	270 (78.3)	.03	88 (85.4)	22 (71.0)	36 (94.7)	39 (86.7)	185 (85.3)	.05	50 (78.1)	3 (100)	13 (81.3)	14 (82.4)	80 (80.0)	.81
Alcohol non-use	21 (24.7)	33 (28.9)	8 (13.1)	13 (15.3)	75 (21.7)		15 (14.6)	9 (29.0)	2 (5.3)	6 (13.3)	32 (14.7)		14 (21.9)	0 (0)	3 (18.8)	3 (17.6)	20 (20.0)	
≥ 1 drink per week	57 (89.1)	69 (86.3)	48 (88.9)	64 (88.9)	238 (88.1)	.78	76 (85.4)	20 (91.0)	28 (77.8)	35 (89.8)	159 (85.5)	.64	35 (70.0)	2 (66.6)	11 (84.6)	12 (80.0)	60 (60.0)	.78
≤ 1 drink per week	7 (10.9)	12 (13.8)	6 (11.1)	8 (11.1)	33 (11.9)		13 (14.6)	2 (9.0)	8 (22.2)	4 (10.3)	27 (14.5)		15 (30.0)	1 (33.3)	2 (15.4)	3 (20.0)	20 (20.0)	
Fruit and Vegies**																		
<5 per day N(%)	66 (77.6)	64 (56.1)	38 (62.3)	55 (64.7)	223 (64.6)	0.01	78 (75.7)	23 (74.2)	28 (73.7)	28 (62.2)	157 (72.4)	.39	50 (78.1)	3 (100)	11 (68.8)	10 (58.8)	74 (74.0)	.27
≥5 per day N(%)	19 (22.4)	50 (43.9)	23 (37.7)	30 (35.3)	122 (35.4)		25 (24.3)	8 (25.8)	10 (26.3)	17 (37.8)	60 (27.6)		14 (21.9)	0 (0)	5 (31.3)	7 (41.2)	26 (26.0)	

*Alcohol consumption during the last 30 days. **Fruits and Vegetables consumption per day

Relationships between subgroups of sport and non-sport participation with sedentary behaviour among males from late adolescence to young adulthood

Screen time remains high in all the subgroups across the studied years, especially during the weekends; in wave 1 we encountered significant differences between groups in this sedentary behaviour during weekdays (X^2=8.39; p .03) and weekends (X^2=20.71; p .001), being NSI the ones spending more time in front of the screen (table 13). Sitting for transport also present some significant differences between groups (p <.05) across the waves; TS and IS are generally the subgroups spending more time sitting for transport. Time sitting in class during weekdays considerably reduces in three out of four of the subgroups (NSI, TS and IS) (-87 minutes per subgroup) while sitting for transport increases in all the subgroups (+35 minutes per subgroup). Total daily sitting time is higher during the weekdays compared to weekends and non-sport participant males (NSA and NSI) present higher means of total sedentary behaviour; however the differences between groups are not significant (p <.05) (Table 14).

Table 14. Relationship between subgroups of sport participation with sedentary behaviours among males.

	2012					2013					2014				
Sport VS No sport	**NSI N=36**	**NSA N=54**	**TS N=164**	**IS N=62**	**p value**	**NSI N=29**	**NSA N=28**	**TS N=97**	**IS N=40**	**p value**	**NSI N=28**	**NSA N=6**	**TS N=31**	**IS N=15**	**p value**
Time sitting on weekdays Minutes per day Mean(SD)															
Screen time	224 (115)	186 (121)	192 (137)	219 (116)	.03	178 (107)	177 (113)	194 (108)	162 (98)	.39	225 (145)	230 (203)	198 (145)	158 (110)	.37
Sitting for educational reasons	433 (104)	431 (86)	423 (74)	426 (76)	.97	432 (90)	417 (67)	411 (63)	415 (62)	.97	350 (135)	470 (219)	317 (151)	352 (152)	.32
Others hobbies	103 (88)	87 (80)	85 (84)	82 (92)	.54	61 (47)	95 (80)	85 (77)	81 (67)	.48	107 (79)	220 (145)	108 (64)	109 (79)	.18
Sitting for Transport	25 (35)	24 (43)	20 (23)	29 (51)	.75	16 (14)	15 (13)	28 (44)	16 (23)	.01	60 (56)	70 (58)	56 (55)	53 (47)	.92
Total daily sitting time	782 (213)	726 (214)	747 (181)	730 (166)	.40	688 (126)	705 (194)	720 (146)	676 (140)	.39	743 (220)	990 (558)	680 (261)	672 (186)	.30
Time sitting on weekends Minutes per day Mean(SD)															
Screen time	352 (166)	231 (165)	273 (168)	317 (137)	.001	281 (190)	273 (159)	277 (160)	243 (144)	.76	274 (184)	305 (147)	194 (136)	165 (110)	.09
Sitting for educational reasons	67 (66)	89 (110)	98 (104)	76 (80)	.57	99 (92)	91 (72)	62 (62)	64 (68)	.03	63 (59)	130 (142)	91 (133)	105 (99)	.50
Other hobbies	150 (113)	175 (110)	149 (114)	161 (135)	.39	130 (92)	178 (107)	143 (107)	177 (128)	.19	177 (116)	350 (174)	178 (71)	191 (112)	.09
Sitting for transport	27 (22)	41 (46)	43 (40)	48 (47)	.08	27 (26)	29 (29)	48 (48)	41 (50)	.05	46 (51)	90 (110)	42 (37)	53 (77)	.68
Total sitting time	600 (237)	541 (266)	587 (227)	581 (287)	.56	540 (222)	572 (238)	531 (208)	526 (227)	.78	562 (248)	875 (475)	506 (275)	514 (164)	.09

Relationships between subgroups of sport and non-sport participation with sedentary behaviour among females from late adolescence to young adulthood

Non-sportive and sedentary females spend more time sitting in front of screen than their active and sportive colleagues (except for team sport participant females in wave 3), and the differences remain significant during weekdays in wave 1 (X^2= 12.94; p .005), wave 2 (X^2= 11.03; p .01) and wave 3(X^2= 9.22; p .02); during weekends, the difference appears significant uniquely in wave 1 (X^2= 15.96; p.001) (Table 15). Total daily sitting during weekdays also presents significant differences between groups across the three waves: wave 1 (X^2= 12.70; p .005), wave 2 (X^2= 11.23; p .01) and wave 3 (X^2= 7.12; p .06). In wave 1 and 2 NSI have the higher means of total sitting time during weekdays, while in wave 3 TS takes the lead. Females spend more time in other hobbies compared to males, and in general, females doing no sport sit more time doing sedentary hobbies. However, the differences between the subgroups are non-significant except for wave 1 (weekdays) (X^2= 10.26; p .01). Time sitting in class during weekdays considerably reduces from 2012 to 2014 in all the subgroups (NSI, TS and IS) (mean of -83 minutes per subgroup) while sitting for transport increases in three out of four of the subgroups (NSI, TS and IS) (mean of +32 minutes per subgroup) (Table 15).

Table 15. Relationship between subgroups of sport participation with sedentary behaviours among females

	2012					2013					2014				
Sport VS No sport	**NSI N=84**	**NSA N=114**	**TS N=61**	**IS N=85**	**p value**	**NSI N=103**	**NSA N=31**	**TS N=38**	**IS N=45**	**p value**	**NSI N=64**	**NSA N=3**	**TS N=16**	**IS N=17**	**p value**
Time sitting on weekdays Minutes per day Mean(SD)															
Screen time	217 (150)	160 (99)	179 (124)	146 (110)	.005	177 (104)	156 (97)	151 (97)	120 (78)	.01	191 (129)	120 (51)	261 (197)	121 (61)	.02
Sitting for educational reasons	454 (109)	463 (86)	454 (94)	468 (92)	.71	471 (85)	417 (137)	468 (62)	465 (73)	.44	396 (128)	340 (34)	409 (179)	360 (165)	.77
Others hobbies	123 (99)	132 (102)	129 (97)	97 (93)	.01	114 (80)	128 (108)	113 (92)	87 (72)	.19	174 (148)	220 (225)	165 (129)	112 (71)	.50
Sitting for Transport	37 (61)	27 (31)	27 (35)	26 (27)	.92	32 (45)	35 (35)	22 (16)	26 (28)	.30	63 (65)	20 (8)	60 (51)	61 (49)	.48
Total daily sitting time	835 (243)	784 (169)	804 (194)	724 (165)	.005	796 (174)	738 (152)	755 (165)	698 (144)	.01	826 (259)	700 (187)	897 (349)	656 (197)	.06
Time sitting on weekends Minutes per day Mean(SD)															
Screen time	290 (179)	237 (135)	198 (156)	209 (140)	.001	233 (151)	198 (109)	172 (103)	190 (136)	.12	191 (122)	160 (121)	199 (111)	143 (114)	.63
Sitting for educational reasons	106 (80)	118 (83)	106 (96)	105 (77)	.51	139 (113)	140 (113)	101 (74)	104 (69)	.18	129 (98)	30 (30)	140 (69)	135 (95)	.11
Other hobbies	195 (136)	217 (126)	203 (134)	175 (121)	.09	205 (118)	205 (99)	185 (125)	171 (99)	.54	290 (181)	475 (500)	242 (157)	191 (139)	.14
Sitting for transport	51 (45)	50 (54)	52 (48)	46 (47)	.72	50 (53)	60 (60)	45 (40)	47 (53)	.66	47 (42)	50 (34)	69 (48)	22 (21)	.01
Total sitting time	643 (275)	619 (239)	561 (262)	538 (244)	.02	630 (289)	571 (211)	504 (221)	546 (234)	.06	658 (268)	715 (370)	652 (323)	494 (232)	.24

Discussion

PA levels and subgroups of sport participation: prevalence and changes throughout late adolescence and early adulthood.

Study 2 aimed (i) to identify levels of PA and sport participation and (ii) cross-sectional associations between PA patterns and the adoption of health-related behaviours (alcohol and tobacco consumption, fruits and vegetable intake and sedentary behaviour) among late adolescents (16-18 years of age) and early adults (18-19 years of age). The data gathered and the conclusions extracted help us to deepen about how health related behaviours change and associate across late adolescence and early adulthood.

The first result of the study indicates that sport participation and PA levels are higher among males compared to females. The literature reviewed is consistent about the higher levels of PA and sport participation amongst males compared to females (Hallal et al., 2012; Ruiz et al., 2011), and in Spain similar results have been found (Tercedor et al., 2007). The present study found that males compared to females spend more total METs per week in all the studied years (+1105 METs per week in 2012; +1795 METs per week in 2013; and +1224 METs per week in 2014), and, similarly, the prevalence of sport participation is higher in males (+29% in 2012; +32% in 2013; and +24% in 2014). Total METs extracted from the IPAQ-A are high in males and females (> 3700 METs-min/week), which might be, in part, due to over-reporting (Hallal et al., 2010); however, the prevalent and significant lower levels of PA and sport participation

encountered in females indicate the need to investigate the several aspects related to PA behaviour and sport participation by gender (Aarnio et al., 2003).

The second result emphasizes the importance of sport participation to maintain adolescents active during the transition from adolescence to early adulthood. Our results suggest that, although sport participants reduce among males and females from wave 1 to wave 3 (-13.8% and -9.3% respectively), those adolescents who played one sport increase the chances of achieving enough MVPA as early adults. Similar results have been found among other Spanish studies (Serrano et al., 2011; Silva et al., 2010). In the present research it was detected that when participants reached adulthood, there was a sharp decrease of the amount of individuals who achieved the MVPA recommendations. This decline was less accentuated among individuals playing one sport (either team or individual). Being aware the importance to study and intervene during the period of transition from adolescence to adulthood to avoid PA decrease and to prevent metabolic syndromes (Ferreira et al., 2005), this finding, not studied before among Catalan students, may help to develop new PA promotion strategies in this age group.

Associations between subgroups of sport participation and health related behaviours

Our third result found significant associations between alcohol and cigarette consumption and sport participation among amateur athletes' males across the three years of the study, finding significant differences during the high school years (wave 1 and 2). Team sports participants (males) present a higher prevalence of alcohol

consumption during the last month, a higher frequency of alcohol consumption and a higher prevalence of smoking behaviour. Indeed, Moore & Werch (2005) concluded that some sports were associated with an increased likelihood of substance use and similar findings were found in other research (Wichstrom & Wichstrom, 2008; Eitle, Turner, & Eitle, 2003). The present research indicates that the association between team sport participation and substance use is constant across late adolescence and early adults among a group of youth from Osona. This finding is new in the Catalan context. In consequence, it is essential to introduce the promotion of health related behaviours in the sport clubs and sport associations from Catalonia in order to combat this positive association between sport participation and substance use.

Our fourth result indicates that, on the one hand, sitting time is a prevalent behavior amongst adolescents from Osona during weekdays (> 700 minutes per day); and, on the other hand, sport participation is significantly associated with screen time. In general, adolescents (especially females) who do not practice any sport spend more minutes a day in front of screen for non-educative reasons. This finding is consistent with previous research showing an inverse relationship between sitting time and levels of PA (Bennie et al., 2013) and supports the hypothesis from a previous Spanish result that total time spent in front of screen is associated with reduced MVPA (Serrano et al., 2011). During the course of the present research 16 interviews (12 in 2012 and 4 in 2014), have been conducted (appendix 17). Although the results are not included in the present thesis some of the comments may help to understand this negative association, because for the interviewees the use of screen time was very easy and addictive, while PA required a lot of preparation and effort.

Considering the high prevalence of adolescents from our sample exceeding the American Academy of Pediatrics recommendations for screen time (≥2h/day), also found in other European adolescents (Rey-López et al., 2010), our results suggest that time spent at a screen may conflict, in some cases, with the available time to be active. Some strategies can be applied to reduce prolonged sitting: modifying the use of screen time (especially the use of the computer for non-education activities), combining some PA during school time (high school students spend over 400 minutes a day sitting for educational reasons) and promoting active transport during late adolescence (passive transport notoriously increase from wave 1 to wave 3), appear to a possible target to reduced sedentary behaviour among late adolescents.

Implications for Public Health

The present study analyses the health behaviours from a sample of Catalan teenagers and finds the relationships between PA, sport participation and other health related behaviours (alcohol and tobacco consumption, fruit and vegetable intake and sedentary behaviour). The data gathered and the conclusions extracted increase our awareness about the lifestyle behaviours of late adolescents and early adults in a Catalan context. The previously mentioned national strategies to improve Spanish and Catalan youth health (PAAS and NAOS) look for different areas working together in order to achieve a common goal: To encourage adolescents to adopt a healthy lifestyle. In this context, our study emphasise the importance that different settings work together and coordinated to achieve the main goals. For example, substance use needs to be prevented in the schools as well as in sport clubs and associations; too

much sitting time needs to be prevented in the community by proposing active leisure time activities, as well as in the schools, where adolescents spend most of their time sitting; sport participation needs to be promoted in the community, within the group of friends and inside the family setting in order to avoid sharp decrease of PA from adolescence to early adulthood. Besides, our results suggest that strategies to achieve one of the main aims proposed by the Catalan government: Increase the mean starting age of alcohol drinking (> 16.5 years old) (Agència de Salut Pública de Catalunya, 2013) should be implemented in sport clubs and associations.

Limitations, future directions and conclusions

Questionnaire used: changes from the previous questionnaire.

Four main changes were applied from the questionnaire used in the study 1 (chapter 4). Firstly we used the IPAQ-A instead of the PAQ-A; PAQ-A was developed to assess general levels of PA for adolescents, whereas the IPAQ-A was thought to involve any kind of youth and adults from 15 to 69 years of age (Hagstromer et al., 2008). The IPAQ-A has reasonable validity properties for assessing activities in different intensities and in different domains (Hagstromer et al., 2008). Secondly, it was important to add a specific question about sport participation and type of sport practiced, in order to be consistent with our main aims and the limitations encountered in the previous research. Thirdly the socio-economic section was deleted from the questionnaire; our previous experience told us that a large number of adolescents did not fill up this part and, moreover, the participants expressed their discomfort to complete it; this

discomfort could negatively affect the rest of the questionnaire (Bailey, 1997). Although we are aware about the effects of socio-economic aspects to PA and other lifestyles, it was not our main aim to compare these two variables, and we followed a golden rule in survey construction "do not ask for information unless you can act on it" (Fink & Kosecoff, 1985, p. 25).

Finally, we decided to include a new variable to be measured; sitting time was added to the final questionnaire to see how it changes across high school and university, and to see whether it affects or not levels of PA. Sitting time is seen as an independent variable for specific health related problems (Martinez-Gómez et al., 2010) and, in general, it is not associated with adolescents' MVPA (Mark & Janssen, 2008). However, the associations between these two behaviours are not always consistent.

Main limitations

First of all the study used self-report data to determine levels of PA which can provokes, especially, an overestimation of PA levels (Ekelund et al., 2011). Although the environmental and social changes occurred during adolescence may influence the levels of PA performed in some specific domains, the high amount of METs-minutes/week encountered in all the waves and, the overestimation problems found in IPAQ (Rzewnicki, Auweele, & Bourdeaudhuij, 2003), bring us to conclude that objective measurements would be necessary to find the exact amount of METs spent, especially at home and at school/work. A literature research was performed before choosing the IPAQ-A to see strengths and weaknesses of this questionnaire, especially

among adolescents (appendix 18). Some studies reported overestimated levels of PA when using this questionnaire (Ceschini & Junior, 2006; Johnson-Kozlow, Sallis, Gilpin, Cheryl, & Pierce, 2006) or large amounts of unreported time (Arvidsson, Slinde, & Hulthèn, 2005). However, other studies highlight the trait of the IPAQ-A to detect the least and highly active (Hagströmer et al., 2008), the utility to use the IPAQ to compare levels of PA with other health related variables (Arvidsson et al., 2005) and the fact that in the guidelines to score this questionnaire they put a maximum min/week for every domain (De Cocker et al., 2011). Secondly, the final sample sharply reduced in the last wave of the study and, as a consequence, there were some groups (i.e. non-sport participant-active females) which presented a very low N and negatively affect the interpretation of the results. Different reasons may be encountered for this sharp reduction, however, the fact that participants had to access to our website and complete the questionnaire, was the main obstacle to achieve a bigger sample. Finally, the different questionnaires used evaluating levels of PA and sport participation make impossible to compare the MVPA scores from study 1 and study 2.

Future research

Future research is needed to reinforce the feasible relationship between these variables across different types of sports and specific levels of PA. Extra longitudinal data would help us to see the evolution of this relationship across adolescence and beginning of adulthood. Qualitative data would help us to find deeper understanding about the incongruent association between substance use and sport participation.

Final conclusion

Despite the mentioned limitations, some significant and relevant results were found, which need to be considered. Participating in sports -particularly TS males- was associated to a higher alcohol and smoking consumption than doing no sport. These results emphasize the importance that sport clubs (including coaches, venue and management team) should provide to their athletes the promotion and the facilities to adopt other healthy habits. Sedentary behaviour is prevalent and notoriously high among all adolescents, without big significant differences between groups.

CHAPTER 5.

STUDY 3 - Longitudinal prospective study: analysing the changes from adolescence to early adulthood

CHAPTER 5. Study 3: Longitudinal prospective study: analysing the changes from adolescence to early adulthood

Overview and purpose

Tracking the transition point from adolescence to adulthood, will allow understanding how lifestyle patterns adopted during high school can influence the adoption of healthy lifestyles at university (Wengreen & Moncur, 2009). Since (i) a high percentage of Spanish teenagers (28.6%) go to University on this transition period (Ministerio de Educacion, Cultura y Deporte, 2013b), (iii) PA levels significantly drop during this transition point across countries -including Spain- (Roman et al., 2006) and, (iv) the abandon of sport participation is associated to the adoption of unhealthy lifestyles, as previously found (Audrain-Mcgovern et al., 2012); research is needed to examine how PA and sport participation patterns in high school relates to the adoption of other health-related behaviours when adolescents reach university. This descriptive longitudinal study will provide extra valuable information for developing interventions aiming at improving Spanish early adults' healthy behaviours through PA and sport participation.

This study aims (i) to identify changes in patterns of health related behaviours from adolescence to early adulthood and, (ii) to identify how sport participation in high school influence the adoption of other health-related behaviours (smoking; alcohol, fruit and vegetable consumption; sitting time) when adolescents reach university.

Furthermore, predictors of change of sport participation and MVPA reduction will be studied.

Study design and sample

A longitudinal prospective study design was used. Based on the same sample of study 2 (Wave 1, n=662; Wave 2, n=411; Wave 3, n=180), the study population were adolescents that completed the survey across wave 1 (2012), wave 2 (2013) and wave 3 (2014) and could be tracked from their last two years of high school to their first year of University at 17, 18 and 19 years of age respectively (n=180, 80 males, 100 females). The same exclusion criteria as applied in study 2 were used for study 3. All participants had signed a written informed consent as part of study 2, which also applied to study 3. Approval from the Ethics Comitte of University of Vic-University of Catalonia obtained for study 2 also included study 3.

Survey

PA levels across different domains (at university, at home, at work, during leisure time, for transportation) (IPAQ-A; Wetton et al., 2013), sport participation (Wetton et al., 2013), sitting time (Active Where? Survey; Joe & Carlson, 2010), alcohol, and tobacco consumption (FRISC questionnaire; Comin et al., 1997), fruits and vegetables

consumption STEPS instrument (Organizacion Mundial de la Salud (OMS), 2003), perceived barriers to exercise (Sas-Nowosielski, 2007), and demographic information (date of birth, height and weight) were measured by using the same 42-item questionnaires described in study 2.

Variables measured and questionnaire used

A detailed description of variables and measurements has been provided in Study 2.

Data collection

The data collection procedure followed in study 3 has been described in detail in study 2. Briefly, for Waves 1 and 2, the director of each secondary school in the county of Osona (Barcelona) was asked for permission to conduct a survey to the same group of students across years 17 and 18. After verbal permission was obtained, the researcher went to each school at a set date and time to handle the survey and obtained written informed consent to students. Students completed the survey and returned it to the researcher. Discount vouchers for clothes shops and concert tickets, as well as a bracellet specially designed for the project (Gen95) were given to all participants that completed the survey.

For Wave 3, students were firstly sent an email (n=483), to the email address they had provided in Wave 1 as a reminder of the project (November and December, 2013). A brief summary of results from Waves 1 and 2 (which included a description of the most prevalent health-related behaviours in adolescents from Osona) was included to increase students´ responsiveness. Students were then informed about the content of the project Website (gen95.uvic.cat) as well as the services it offered.

Due to the poor response obtained from emails (only 34 students responded out of 455), a welcome message was sent to students´ Facebook accounts (n=543) to remind them about the project, its website and requesting to be their Facebook friends (January, 2014). Two hundred and eighty-two students out of 543 accepted the invitation. Students had voluntarily provided their Facebook accounts during Wave 1.

During the following month (February, 2014) the project website was used as a platform to involve students in Wave 3 of the project by providing updated information about social and cultural events performed in the county of Osona every week.

End of February 2014, emails (n=483) and facebook messages were sent to all the contacts available (n=282) requesting to complete a short survey online (15 minutes). The message included the link to the online survey as well as the availability to several prizes after survey completion (e.g. providing one euro for every completed questionnaire to a NGO settled in Gambia *(Abaraka Bake)*; raffling three free dinners at a popular restaurant in Vic among the 50 first students that completed the survey; raffling three 30 euros vouchers in Amazon among the second group of 60 estudents completing the survey). After this process, a total of 70 questionnaires were

completed. In order to increase participant´s response, during the following two months (March and April, 2014), weekly email and Facebook messages were sent to students reminding to complete the survey; increasing the response to 110 completed questionnaires. Finally (May 2014), 100 euros were raffled among participants who completed the questionnaire; achieving a response of 180 students in June 2014. In summary, a total of 210 participants accessed the online survey, with 30 repondents having to be dismissed due to incompletion of most than 50% of the questionnaire items. Data collection ended when achieving a final response rate of 38% out of a potential sample of 543 (adolescent that gave us some contact information) at the beginning of the summer holidays.

Statistical Analysis

Data on patterns of key outcome variables were described using frequencies (percentage) and means (standard deviation) across the three waves of the longitudinal study. Bivariate linear regression analyses assessed changes of MVPA patterns and sport participation with other health-related behaviours (smoking, alcohol, fruits and vegetable consumption, sitting time and perceived barriers to exercise). The model was adjusted for gender, BMI characteristics smoking status, alcohol consumption, fruit and vegetable intake, PA during leisure time and sedentary time. Predictors for dropping out sport participation were identified by using odds ratio (OR) and 95% confidence intervals (CI). Differences between genders on how PA patterns and sport participation during high school influenced the adoption of other

health-related behaviours were assessed using cross-tabs and the Krwskal & Wallis statistical test. Significance was set at $p < 0.05$ and analyses performed using SPSS, version 21.

Results

Descriptive statistics

A completed baseline (Wave 1; 2012) survey was returned by 662 (96%) respondents, of whom 210 (31%) returned a completed follow-up survey two years later. Of these, 30 had missing PA or sports participation data at follow-up. One hundred and eighty respondents (n=100 females; n=80 males) completed the questionnaires in 2012 and 1014. In 2013 (Wave 2), we have the data from 119 participants out of the 180 (66.1%). Table 16 summarizes descriptive statistics of the sample (mean age, height, weight, BMI characteristics).

Table 16. *Descriptive results of the studied sample.*

	2012 (Wave 1) N=180	**2013 (Wave 2) N=119**	**2014 (Wave 3) N=180**
Gender N(%)			
Males	80 (44.4)	50 (42)	80 (44.4)
Females	100 (55.6)	69 (58)	100 (55.6)
Demographics Mean(SD)			
Age (Years)	17.2 (.5)	18.2 (.45)	19.2 (.50)
Height (m)	1.69 (.09)	1,69 (.09)	1,70 (.09)
Weight (KG)	61.1 (10.1)	61.1 (10.6)	63.1 (11.0)
BMI	21.16 (2.7)	21.28 (2.6)	21.66 (2.7)

Changes in sport participation and PA levels in males and females from adolescence to young adulthood

Sport participation in males and females changed considerably over three years. At the individual level, sport participation stopped in 17% of males (n=14) and 19.0% of females (n=19), started in 8% of males (n=6) and 7% of females (n=7) and, was maintained in 50% of males (n=40) and 28% of females (n=28) (Figures 3 and 4). Within those who maintained, 77.5% of males (n=31) and 48% of females (n=16) played team sport, while 22% of males (n=9) and 52% of females (n=12) were involved in individual sport (Figure 3 and 4). The proportion of male and female respondents not involved in sport but meeting the PA recommendations decreased in 20% (n=16) and 32% (n=32) respectively (Table 17).

Figure 3. *Changes in levels of sport participation from baseline to follow-up 2 years later among males (n=80).*

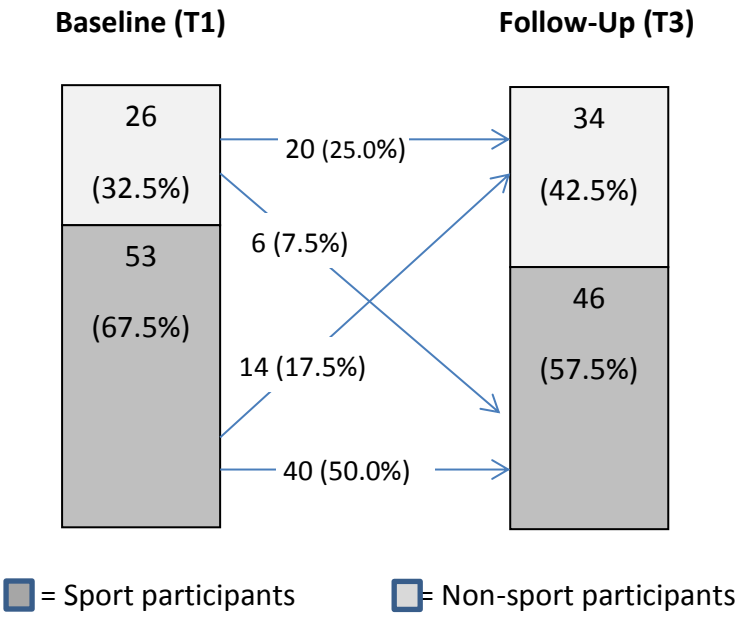


Figure 4. *Changes in levels of sport participation from baseline to follow-up 2 years later among females (n=100).*

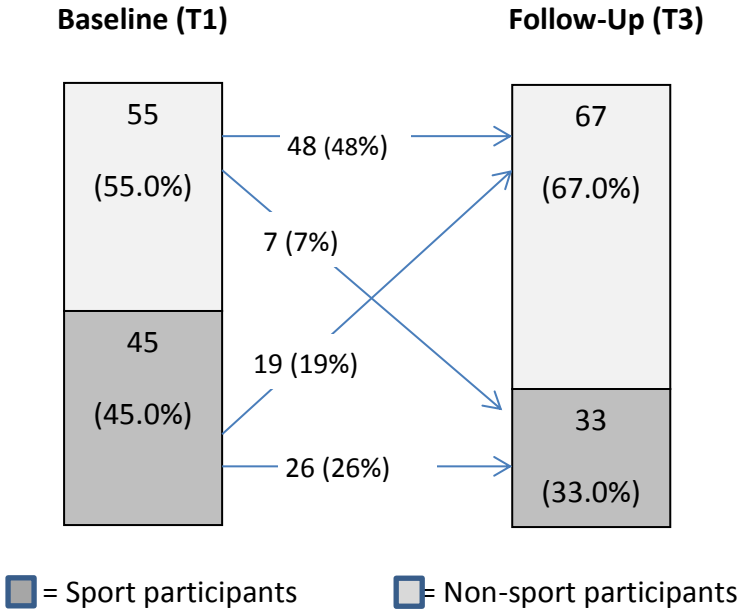


Table 17. *Percentage of sport participants, active and inactive males and females across the waves.*

	2012 (Wave 1)			2013 (Wave 2)			2014 (Wave 3)		
	Males (n=80)	**Females (n=100)**	**X^2 (p. value)**	**Males (n=50)**	**Females (n=68)**	**X^2 (p. value)**	**Males (n=80)**	**Females (n=100)**	**X^2 (p. value)**
Sport Participation N(%)			**28.82 (≤.001)**			**16.19 (.001)**			**17.99 (≤.001)**
Individual Sport (IS)	13 (16.3)	29 (29.0)	≤.001	12 (24.0)	22 (30.9)	.001	15 (18.8)	17 (17.0)	≤.001
Team Sport (TS)	41 (51.3)	16 (16.0)	≤.001	21 (42.0)	9 (13.2)	.001	31 (38.8)	16 (16.0)	≤.001
No sport/ physically active (NSA)*	22 (27.5)	35 (35.0)	≤.001	8 (16.0)	7 (11.8)	.001	6 (7.5)	3 (3.0)	≤.001
No Sport / inactive (NSI)	4 (5.0)	20 (20.0)	≤.001	9 (18.0)	30 (44.1)	.001	28 (35.0)	64 (64.0)	≤.001

*Do not practice sport but do 300≤ min/week of PA during leisure time.

The amount of participants who achieved at least 60 minutes of moderate to vigorous PA during leisure time 5 days a week also reduced noticeably in 36% of males (n=29) and 30% of females (n=30) over the three time points (Figures 5 and 6).

Figure 5. *Changes in levels of PA during free time from baseline to follow-up 2 years later among males (n=80).*

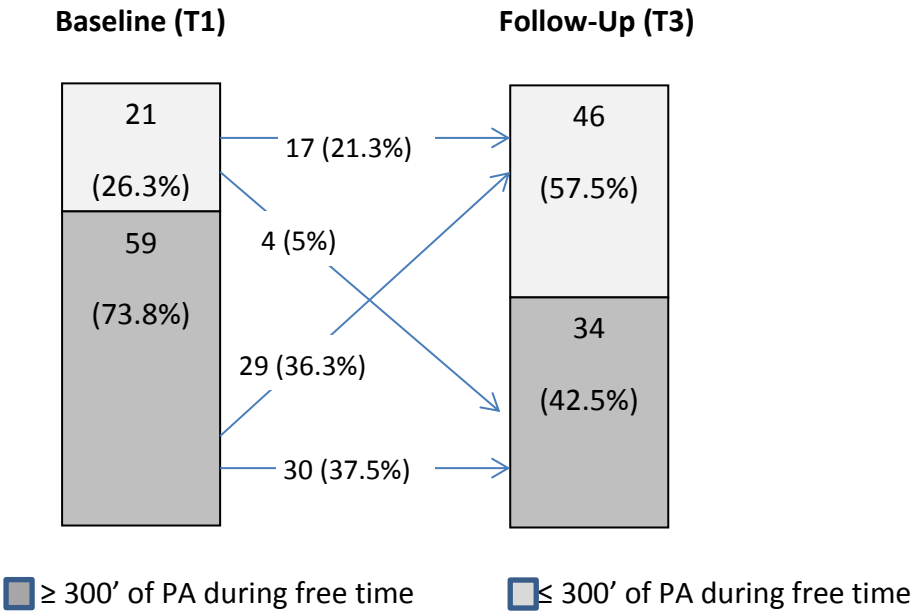
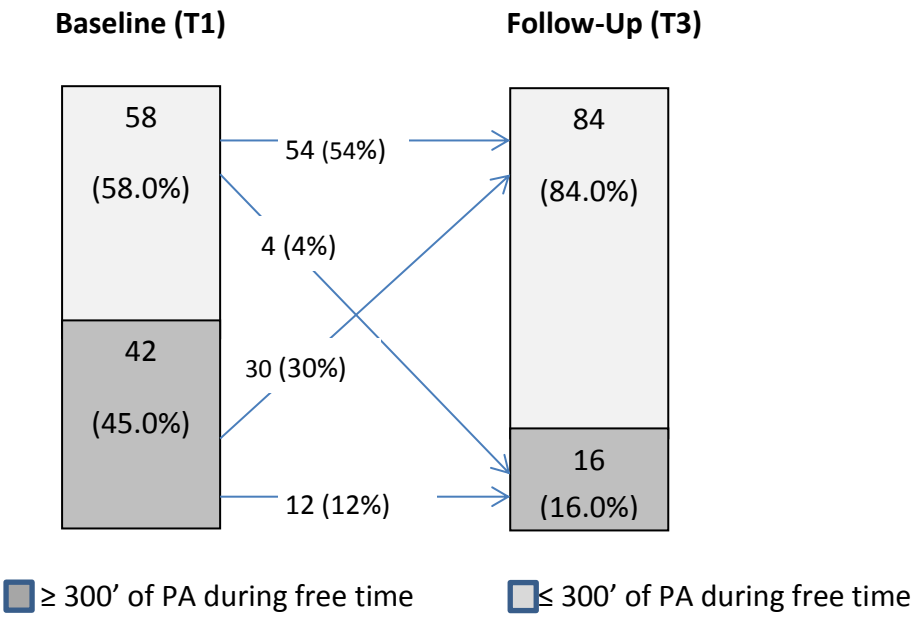


Figure 6. *Changes in levels of PA during free time from baseline to follow-up 2 years later among females (n=100).*



Changes in total and domain-specific energy expenditure (METs-hour-week) across genders

Table 18 summarizes descriptive statistics about (i) total energy expenditure (MET-minutes/week) and (ii) energy expenditure across domains (MET-minutes/week in males and females. Total energy expenditure changed little over three years in males (-36 MET-minutes/week), while an increase was observed in females (+290 MET-minutes/week) across the years. Significant differences between genders are prevalent across the three years in METs spent at leisure time ($p \leq .004$). As expected by the figures showed above, energy expenditure spent at leisure time declined in both genders by a mean of -559 MET-minutes/week in males and a mean of -408 MET-minutes/week in females (Table 18).

Energy expenditure spent at school/work and at home increased similarly in males (+495 MET-minutes/week and +255 MET-minutes/week respectively) and females (+413 MET-minutes/week and +183 MET-minutes/week respectively). Energy expenditure spent from travelling from one place to another declined in males by a mean of -225 MET-minutes/week but increased in females with a mean change of + 99 MET-minutes/week (Table 18).

Table 18. *METs expenditure from the different IPAQ-A domains across waves among males and females.*

	2012 (Wave 1)			2013 (Wave 2)			2014 (Wave 3)		
	Males (N=80)	**Females (N=100)**	**p. value**	**Males (N=50)**	**Females (N=68)**	**p. value**	**Males (N=80)**	**Females (N=100)**	**p. value**
IPAQ domains METs-Minute/Week Mean(SD)									
PA at work/school	1336 (1237)	1021 (962)	.06	1529 (1897)	1416 (2022)	.75	1831 (3094)	1434 (2065)	.30
PA transport	733 (1048)	589 (588)	.27	506 (702)	664 (598)	.19	508 (376)	688 (646)	.02
PA at home	726 (784)	643 (728)	.46	651 (701)	731 (758)	.56	981 (978)	826 (828)	.25
PA at leisure	2559 (1821)	1552 (1230)	≤.001	2314 (1910)	1401 (1456)	.004	2000 (1913)	1144 (1175)	≤.001
TOTAL PA	5356 (2732)	3806 (2062	≤.001	5002 (3298)	4213 (2991)	.17	5320 (4096)	4096 (2972)	.02

Changes in lifestyle behaviours between genders

On the one hand, the differences between genders regarding health related behaviours are in general non-significant (p >.05) (Table 19). Uniquely, frequency of alcohol consumption is significantly higher in males in two out of three waves (p ≤.03) (Table 19). On the other hand, the health related behaviours slightly change across the years. Among males there is a stability of cigarette consumption (+.2%) and mean of cigarettes consumed per day (-.53 cigarettes per day) across the years. The prevalence of alcohol consumption during last month (-5%) and weekly alcohol consumption (+4%) also remain stable. The most substantial changes can be observed in fruits and vegetables consumption per day (-.25 vegetables per day; -.37 fruits per day). Among females (Table 19), more changes can be observed. The amount of currently smokers (+ 11%) notoriously increased over the years, as well as the frequency of alcohol

drinking: in 2012 very few females used to drink more than once a week (6.1%); this percentage rises to 25.6% in 2014. Similarly to males, fruit consumption also presents an important decrease across the years (-.48 fruits per day), and this affects the amount of females achieving the fruit and vegetable recommendations (-4%) (Table 19).

Table 19. *Health related behaviours across waves among males and females.*

	2012 (Wave 1)			**2013 (Wave 2)**			**2014 (Wave 3)**		
	Males (n=80)	**Females (n=100)**	**p. value**	**Males(n =50)**	**Females (n=68)**	**p. value**	**Males (n=80)**	**Females (n=100)**	**p. value**
Cigarette									
Smokers N(%)	26 (32.5)	24 (24.0)	.20	13 (26.0)	18 (26.1)	.95	26 (32.7)	35 (35.0)	.67
Cigarettes per day Mean(SD)	4.72 (4.71)	4.11 (3.38)	.24	4.00 (3.64)	4.43 (2.92)	.75	4.19 (4.76)	2.83 (2.82)	.64
Alcohol N(%)									
Alcohol during last month*	70 (87.3)	81 (81.0)	.25	37 (74.0)	60 (88.2)	.04	66 (82.5)	80 (80.0)	.67
≥ 1 drink a week	24 (30.3)	7 (6.1)	.004	14 (37.8)	7 (11.4)	.03	23 (34.8)	20 (25.0)	.14
Fruit and Vegies									
Vegetables per day Mean(SD)	1.90 (1.19)	1.74 (1.07)	.69	1.70 (.99)	1.59 (.91)	.53	1.65 (1.17)	1.72 (1.16)	.35
Fruits per day Mean(SD)	2.06 (1.23)	2.11 (1.17)	.75	1.98 (1.40)	1.97 (1.24)	.96	1.69 (1.15)	1.63 (1.25)	.79
≥ 5 fruit and veg per day N(%)	31 (39.2)	30 (30.0)	.19	16 (32.0)	19 (27.9)	.63	21 (26.3)	26 (26.0)	.97

*% of adolescents who have drunk alcohol during the last month.

Changes in sedentary behaviours between genders

How much time participants spend in front of screen, as a way of transport, total hobbies (playing music, reading, talking with friends and doing arts) and sitting for educational reasons (in class and doing homework) was analysed. Mean of total sitting time was higher for females than males in all the waves being significant in waves 2 and 3 ($p \leq .05$). Significant differences between genders ($p \leq .05$) were detected in

videogames use (males having higher values than female), sitting for educational reasons and total hobbies (females having higher values than males) (Table 20).

Among males, TST reduced over time principally due to a decrease on the use of videogames (-22 min/day) *(table 20)*. However, time spend in front of screen in 2014 remained higher in males compared to females (209 Vs 187 min/day). Amongst females, TST remained stable from wave 1 to wave 3, due to a reduction of the computer use (- 11 min/day), but an increase in TV viewing (+ 13 min/day*)*. As expected, late adolescents spend much less time sitting in class when they go to university than when they were in high school (-75 min/day). Males and females increased their time doing sedentary hobbies and sitting for transport from wave 1 to wave 3 (+45 min/day and +30% respectively) (Table 20).

Table 20. *Minutes a day of sedentary behaviour across waves among males and females.*

	2012 (Wave 1)			**2013 (Wave 2)**			**2014 (Wave 3)**		
	Males (n=80)	**Females (N=100)**	**p. value**	**Males (N=50)**	**Females (N=68)**	**p. value**	**Males (N=80)**	**Females (N=100)**	**p. value**
Sitting time Minutes a day Mean(SD)									
TV	89(77)	69(47)	.02	69(50)	81(48)	.19	82(56)	82(67)	.97
Computer	98(68)	105(73)	.60	76(57)	85(64)	.45	87(83)	94(69)	.49
Videogames	61(47)	12(33)	≤.001	43(54)	10(31)	≤.001	39(55)	10(32)	≤.001
Total Screen Time	248(142)	187(99)	.005	190(101)	177(92)	.49	209(133)	187(114)	.24
Sitting for transport	30(35)	31(33)	.23	35(52)	35(40)	.09	60(58)	55(45)	.83
Other hobbies	103 (74)	139(110)	.009	103 (80)	125(75)	.12	138 (82)	194(142)	.001
Sitting educational reasons	423(66)	460(38)	.005	414 (66)	474(71)	≤.001	346(154)	390(141)	.05
Total sedentary time	804(202)	817(159)	.58	742(158)	801(167)	.05	753(271)	826(249)	.05

Associations between subgroups of sport participation in 2012 with BMI and lifestyle behaviours (tobacco, alcohol, fruit and vegetable and sitting time) across the waves.

The subgroups of sport participation are divided according their sport participation in 2012. When analysing males there are only 3 main groups: Team sport participant (TS), individual sport participant (IS) and non-sport participant (NS); due to the amount of non-sport participant and sedentary males in 2012 was too low to do an extra group. Among females, the groups remain the same than the previous study: NSI, NSA, TS and IS.

Males who used to practice a team sport in 2012 present greater alcohol consumption (85%) and frequency of consumption (46% ≥1 drink per week) in wave 3, although the differences between groups are not significant (p = .75 and p = .15 respectively) (Table 21*)*. Similarly, TS participants in 2012 present higher smoking prevalence in 2014 (46.3%; p = .07). The majority of smokers, smoke every day (>60%), although the mean of cigarettes per day is inconstant between the subgroups and across the waves. Participants who practiced an individual sport in 2012 are more prone to achieve fruit and vegetable recommendations than other groups in all the waves; however, significant differences between groups are only present in wave 1 (X^2=5.98, p = .05) (Table 21).

In the first year of the study, NS males spend more total METs per week (5822 METs), than the other subgroups. However, participants who were not doing any sport in 2012, is the subgroup spending less total METs-minute/week (4530 METs) in wave 3. Non-athletes (NS) males spend a good amount of METs during free time in wave 1 (2411 METs); however this number substantially reduce in wave 3 (1616 METs). Team

sport participants show similar patterns of METs reduction at leisure from wave 1 (2568 METs) to wave 3 (1822 (METs) (Table 21).

Males in the NS group increased their total sitting time and their TST from wave 1 to wave 3, while the sport groups (TS and IS) reduced these sedentary behaviours. Sitting as a way of transport presented a sharp increase from wave 1 to Wave 3 in those adolescents who used to practice sport in 2012. Other hobbies (talking with friends, playing musical instruments and reading for pleasure) present a sharp increase across these time frames among NS group. The big majority of IS and TS in wave 1 keep on doing these sports in wave 3. Similar patterns follow non-sport participants (Table 21).

Table 21. *Associations between subgroups of sport participation and health related behaviours among males.*

	2012 (Wave 1)				2013 (Wave 2)				2014 (Wave 3)			
	NS N=26	**IS N=13**	**TS N=41**	**p.**	**NS N=20**	**IS N=8**	**TS N=22**	**p.**	**NS N=26**	**IS N=13**	**TS N=41**	**p.**
BMI (Kg / M²) Mean(SD)												
BMI	22.12 (3.0)	22.22 (2.5)	21.62 (2.8)	.20	22.47 (2.7)	22.31(2.2)	21.43 (2.1)	.35	22.65(3.2)	22.0(1.5)	22.2(2.4)	.77
Lifestyle behaviours N(%)												
Alcohol last month	20 (76.9)	12 (92.3)	37 (92.5)	.14	13 (65.0)	5 (62.5)	19 (86.4)	.20	21 (80.8)	10 (76.9)	35 (85.4)	.75
≥1drink x week	7 (35.0)	2 (16.7)	13 (32.4)	.89	4 (30.8)	3 (37.5)	7 (36.8)	.05	4 (19.1)	3 (30.0)	16 (45.7)	.15
Smokers	7 (26.9)	2 (15.4)	17 (41.5)	.16	2 (10.0)	1 (12.5)	10 (45.5)	.02	7 (26.9)	2 (15.4)	19 (46.3)	.07
Mean of cigarettes per day Mean(SD)	3.6 (3.5)	6 (4.0)	4.9 (5.2)	.79	0	3 ()	4.1 (3.8)	.79	3.8 (3.5)	14 ()	3.5 (4.6)	.08
≥5 fruit and Veg	8 (30.8)	9 (69.2)	14 (35.0)	.05	5 (25.0)	4 (50.0)	7 (31.8)	.44	5 (19.2)	5 (38.5)	11 (26.8)	.43
METs-Minutes per Week Mean(SD)												
TOTAL METs	5822 (2840)	5441 (3250)	5034 (2507)	.61	5505 (2993)	6760 (5062)	3905 (2461)	.06	4530	5017	5918	.51
METs work	1311 (1097)	735 (489)	1543 (1427)	.08	2205 (1879	1393(2936)	964 (1244)	.19	1547(2748)	306 (556)	2494 (3582)	.05
METs Transport	961 (1065)	978 (1764)	511 (652)	.30	510 (369)	597 (1152)	469 (762)	.88	511 (253)	424 (354)	532 (446)	.61
METs House	1138 (985)	898 (784)	411 (449)	.00	716 (553)	1095 (1120)	432 (567)	.08	855 (835)	958 (1065)	1069(1046)	.75
METs at leisure	2411 (2156)	2829 (1662)	2568 (1665)	.73	2073(1771	3674 (2655)	2039 (1577)	.06	1616(1782)	3328 (3022)	1822 (1343)	.14
Screen time Minutes per day Mean(SD)												
Total Screen time	243 (146)	177 (142)	259 (137)	.14	194 (107)	136 (77)	205 (101)	.19	248 (144)	163 (100)	199 (131)	.09
Sitting educational reasons	424 (73)	410 (83)	426 (56)	.72	416 (60)	410 (85)	413 (67)	.97	375 (174)	324 (146)	335 (143)	.76
Transport	30 (28)	21 (20)	26 (32)	.57	24 (34)	59 (50)	32 (40)	.07	46 (44)	41 (42)	49 (43)	.79
Total hobbies	111 (81)	98 (70)	99 (72)	.79	107 (95)	84 (51)	106 (76)	.78	161 (102)	117 (58)	130 (72)	.19
Total Sedentary per day	811 (214)	708 (208)	812 (191)	.24	743 (160)	691 (152)	758 (162)	.60	832 (322)	645 (180)	715 (248)	.08
Sport participation N(%)												
No Sport					14 (70.0)	4 (20.0)	2 (10.0)	.00	21 (80.1)	4 (15.1)	1 (3.8)	.00
Team Sport					2 (9.1)	2 (9.1)	18 (81.8)	.00	11 (26.9)	1 (2.4)	29 (70.7)	.00
Individual Sport					1 (20.0)	6 (75.0)	1 (4.5)	.00	2 (15.4)	10 (76.9)	1 (2.4)	.00

No significant differences were found between subgroups of sport participation and alcohol drinking among females; however females who played one sport in 2012 (TS and IS) have the highest prevalence of alcohol consumption in wave 3 (Table 22*)*. Frequency of consumption (≥ 1 drink a week) presented a sharp increase in the last year of the study in all the subgroups (median of +14%). Females who played Individual sport or were physically active (IS and NSA) in 2012, have the highest prevalence of smoking consumption in waves 2 and 3 (median >30%).

Fruit and vegetable consumption is clearly linked to activity levels, because those who practiced one sport or were NSA in 2012, tended to eat more fruit and vegetable than their NSI age-mates across all the waves. However, the differences between groups are non-significant (Table 22).

As expected, NSI females spent the lowest amount of total METs especially in wave 1 (X^2=40.57 p ≤.001), and remain the group with the lowest MET expenditure in all the waves. Non-sport participant and inactive females have, in general, very low levels of METs consumptions in the different IPAQ domains across the years, showing significant differences in wave 1 and wave 3 in leisure time METs ((X^2=35.81; p ≤.001; X^2=10.61; p ≤.03 respectively) *(*Table 22*)*.

In concordance, NSI females significantly spend more time in front of a screen in wave 1 (X^2=11.24; p .01). However, in wave 3 females who used to play a team sport present a relevant increase of screen viewing (+ 50 min/day) (X^2=16.01; p .001). Sitting for transport and total hobbies presented a sudden upsurge in 2014 in all the groups, without significant differences between groups. In general, total sitting time is higher among the non-sport subgroups (NAS and NSI) in all the waves.

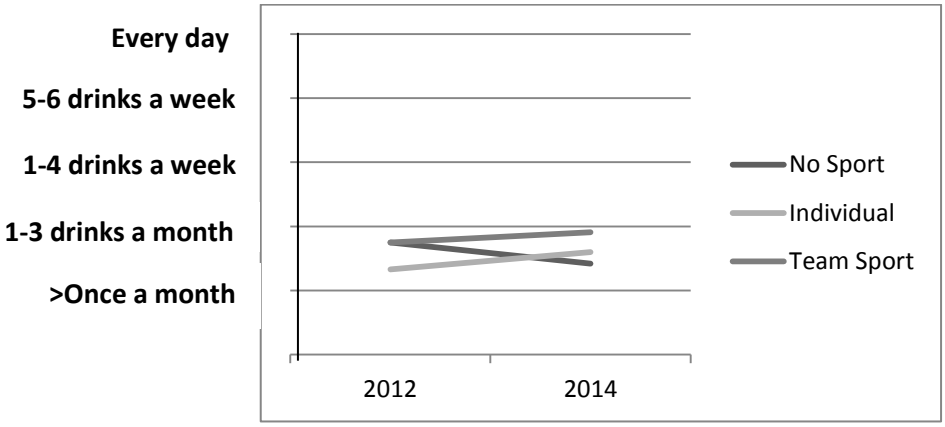
Tracking of sport from wave 1 to wave 3 is only stable when talking about team sport participation (81.3%); IS tracking is below the 50% (41.4%). Only 2.9% of the females who were NSA in 2012 keep these levels of MVPA during free time in 2014, whereas 95% of the NSI females in 2012, stay in the same group in 2014 (Table 22).

Table 22. *Associations between subgroups of sport participation and health related behaviours among females.*

	2012 (Wave 1)					2013 (Wave 2)					2014 (Wave 3)				
	NSI N=20	**TS N=16**	**IS N=29**	**NSA N=35**	**p.**	**NSI N=14**	**TS N=8**	**IS N=23**	**NSA N=23**	**p.**	**NSI N=20**	**TS N=16**	**IS N=29**	**NSA N=35**	**p.**
BMI (Kg/M²)															
BMI Mean(SD)	20.0(2.2)	21.3(2.7)	20.4(2.1)	20.5(2.6)	.29	19.9 (2.0)	21.2(2.1)	20.7(2.2)	21.1(3.4)	.60	20.1(2.3)	22.2(2.6)	20.7(1.9)	21.4(3.3)	.09
Lifestyle Behaviours															
Alc. Last month N(%)	16 (80.0)	12 (75.0)	26 (89.7)	27 (77.1)	.54	13 (92.9)	7 (87.5)	21 (91.3)	19 (82.6)	.75	15 (75.0)	13 (81.3)	27 (93.1)	25 (71.4)	.16
≥1drink x week N(%)	1 (6.3)	1 (7.7)	2 (11.5)	1 (3.7)	.94	1 (7.7)	1 (14.3)	1 (4.8)	4 (21.1)	.09	4 (26.7)	3 (23.1)	7 (25.9)	7 (26.9)	.51
Smokers N(%)	4 (20.0)	4 (25.0)	5 (17.2)	11 (31.4)	.57	2 (14.3)	1 (12.5)	8 (34.8)	7 (30.4)	.41	5 (25.0)	3 (18.8)	11 (37.9)	13 (37.1)	.45
Cigaret. X day M(SD)	1.7 (0.9)	4.0 (4.2)	4.7 (4.1)	4.8 (3.6)	.61	3.6 (3.2)	3.0 ()	4.5 (3.2)	5.4 (3.2)	.69	3.6 (3.2)	1.0 (08)	2.5 (3.1)	3.2 (2.8)	.74
≥5 fruit and Veg N(%)	3 (15.0)	5 (31.3)	10 (34.5)	12 (34.3)	.43	2 (14.3)	3 (37.5)	10 (43.5)	4 (17.4)	.12	3 (15.0)	6 (37.5)	6 (20.7)	11 (31.4)	.34
METs-Minutes per week Mean(SD)															
TOTAL METs	1667 (663)	4369 (1941)	4211 (2348)	4436 (1595)	.00	2790 (1830)	4750 (3299)	4308 (3571)	4798 (2699)	.28	2696 (1415)	4072 (2511)	4458 (2325)	4630 (4251)	.12
METs work	470 (426)	1082 (905)	775 (952)	1511 (1004)	.00	517 (822)	2052 (1997)	1284 (2444)	1873 (1976)	.18	745 (865)	1182 (1582)	1890 (2891)	1565 (1873)	.24
METs Transport	393 (297)	581 (527)	614 (667)	685 (662)	.34	493 (363)	816 (523)	685 (653)	692 (685)	.49	562 (400)	652 (587)	499 (362)	932 (875)	.09
METs House	374 (388)	494 (748)	598 (561)	902 (910)	.06	681 (481)	720 (924)	585 (533)	911(1001	.67	644 (679)	1023(1182	599 (537)	1029(872	.28
METs leisure	429 (454)	2211 (1047)	2223 (1095)	1337 (1200)	.00	1098 (1223)	1160 (1180)	1751 (1872)	1321 (1188)	.63	743 (666)	1214 (821)	1641 (1615)	930 (985)	.03
Sitting (Minutes/day)															
TST Mean(SD)	226(122	185 (90)	138 (71)	206 (96)	.00	180 (86)	174(118	151 (77)	203 (98)	.44	194 (83)	235(165	125 (63)	213(117	.00
Total Transp. Mean(SD)	15 (18)	22 (19)	20 (28)	28 (25)	.28	24 (20)	26 (39)	18 (14)	27 (26)	.70	37 (27)	29 (26)	51 (46)	44 (38)	.21
Educational Mean(SD)	465 (86)	487 (87)	446 (77)	456 (88)	.62	477 (86)	487 (74)	456 (79)	485 (50)	.52	444 (151)	424 (171)	369 (142)	362 (112)	.11
Total hobbies Mean(SD)	114 (74)	101 (59)	134(132)	176 (117)	.07	122 (91)	109 (92)	127 (76)	132 (59)	.90	186 (103)	174 (131)	173 (147)	226 (161)	.43
Total sitting Mean(SD)	821 (177)	797(139)	739 (158)	866 (137)	.01	804 (216)	797 (202)	753 (158)	848 (122)	.30	861 (214)	864 (341)	719 (230)	846 (222)	.10
Sport participation N(%)															
No Sport						9 (64.3)	1 (7.1)	2 (14.3)	2 (14.3)	.00	19(95.0)	0	1 (5.0)	0	.00
Team Sport						2 (25.0)	6 (75.0)	0	0	.00	2 (12.5)	13(81.3	1 (6.3)	0	.00
Individual Sport						8 (34.8)	1 (4.3)	13 (56.5)	1 (4.3)	.00	15 (51.7)	0	12 (41.4)	2 (6.9)	.00
Active						11(47.8)	1 (4.3)	6 (26.1)	5 (21.7)	.00	28(80.0)	3 (8.6)	3 (8.6)	1 (2.9)	.00

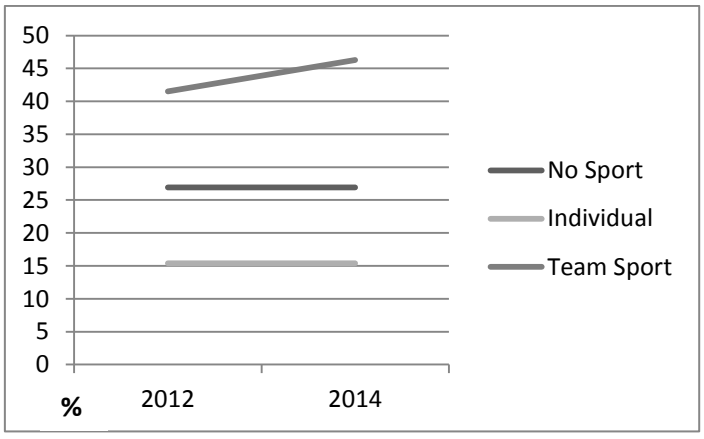
Frequency of alcohol consumption increased over time among sport participant males and decreased among those who were not playing any sport in 2012. As previously confirmed, TS males drink more often than others, although frequency of consumption is generally low in all groups (Figure 7).

Figure 7.*Frequency of alcohol consumption related to sport participation among males from wave 1 to wave 3.*



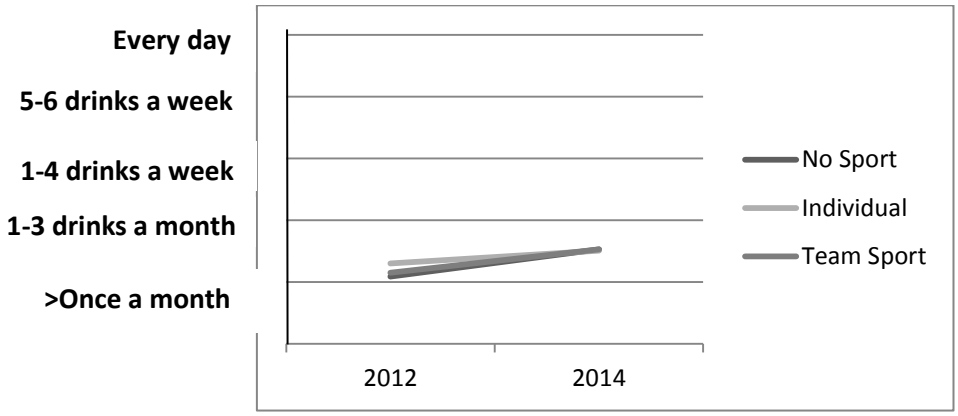
It is significant the highest percentage of TS males who are smokers already in the baseline (42%). Tracking of smoking behaviour remains stable across years, although in TS the percentage of smokers slightly raised over time (figure 6).

Figure 8. *Tracking of smoking across the years divided by subgroups of sport participation among males.*



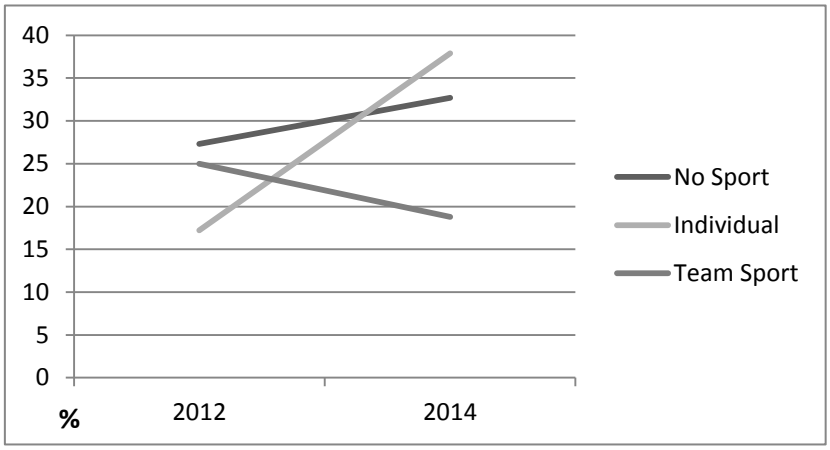
Among females, frequency of alcohol consumption augmented in all groups, without differences between sport participants and non-sport participants (figure 7).

Figure 7. *Frequency of alcohol consumption related to sport participation among females from wave 1 to wave 3.*



Where we could find different premises of tracking was in smoking behaviour. Interestingly, on the one hand, IS sharply increased their cigarette consumption from 2012 to 2014 (+20%), doubling the percentage of the smokers from the baseline. On the other hand, TS substantially reduced their smoking habit across the years (from 25% to 18%) (figure 10).

Figure 10. *Tracking of smoking across the years divided by subgroups of sport participation.*



Fruit and vegetable consumption suffered a significant decrease over time in males and females (*figure 9 and figure 10*). Although, the sample did not reach the minimum intake of fruit and vegetables (5 fruits and vegetables per day) already in 2012, the vast majority of the studied adolescents were worryingly far from the approvals in 2014. Even when controlling the 95%CI, few of them overpass the border line marked by the recommendations. The results suggested that sport participation can be protective for fruit and vegetable consumption in male and females, although more promotion is needed in sport institutions to avoid the decline across adolescence (Figure 11 and 12).

Figure 11.*Fruit and vegetable consumption per day related to subgroups of sport participation among males in wave 1 and wave 3.*

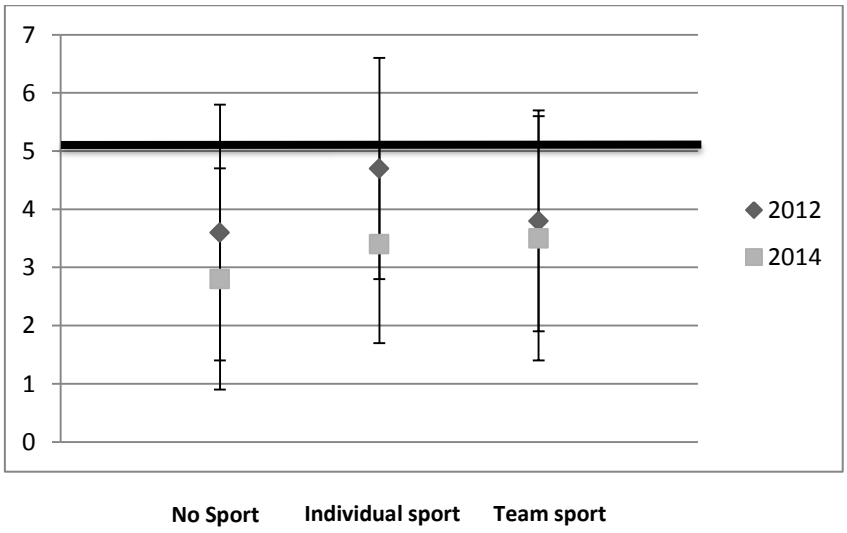
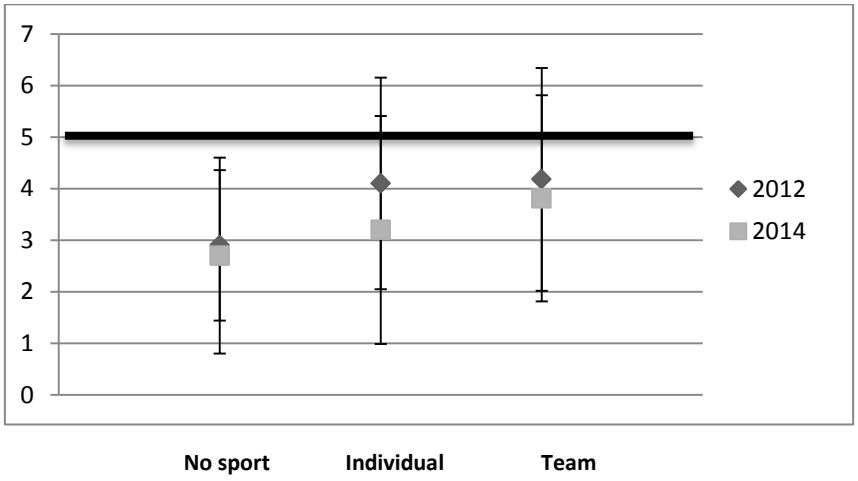


Figure 12. *Fruit and vegetable consumption per day related to subgroups of sport participation among males in wave 1 and wave 3.*



Changes and maintenance in subgroups of sport participation: How this influence to other lifestyle behaviours.

Based on changes occurred from wave 1 to wave 3, different patterns of sport participation (Sport abandon, sport start and sport maintenance) were categorized to find associations with the adoption of specific health-related behaviours (Table 23). Forty-two per cent (n = 11) of participants who abandoned their sport participation increased their alcohol frequency of consumption, 56% (n = 18) failed to meet the 5 servings a day of fruit and vegetable intake in wave 3 and, 75% (n = 24) increased their passive transport. In general, males and females who start doing one sport, present less negative changes in their health behaviours than participants who gave up sport. However, 54% (n = 7) failed to achieve the fruit and vegetables recommendations and 61% (n = 8) increased their sitting time for transport. Among sport maintainers, it is remarkable the 47% (n = 31) of athletes who increased their total screen time and reduced their fruit and vegetable intake; as well as the 67% (n = 44) who increased their sitting time for transport.

Table 23. *Changes and maintenance of sport participation: How this influence to health related behaviours.*

	Sport abandon				Sport start				Sport Maintenance			
	Total N=33	**Males N=13**	**Females N=20**	**p.**	**Total N=13**	**Males N=6**	**Females N=7**	**p.**	**Total N=66**	**Males N=40**	**Female N=26**	**p.**
Alcohol N(%)												
Start drinking alcohol	3 (9.4)	2 (15.4)	1 (5.0)	.55	0	0	0	.22	7 (10.4)	5 (12.5)	2 (7.6)	.59
Increase in Frequency of consumption	11 (42.3)	3 (33.3)	8 (46.7)	.11	4 (50.0)	2 (40.0)	2 (66.7)	.19	13 (24.5)	7 (21.2)	6 (30.0)	.15
Smoking N(%)												
Start smoking	7 (21.9)	2 (15.4)	5 (25.0)	.05	2 (15.4)	1 (16.7)	1 (14.3)	.46	7 (10.4)	1 (2.6)	6 (21.4)	.44
Increase in frequency of smoking	5 (15.6)	2 (15.4)	3 (15.3)	.58	2 (15.4)	1 (16.7)	1 (14.3)	.67	8 (11.9)	4 (10.0)	4 (15.3)	.20
Fruit and vegetables N(%)												
Fail to reach 5 servings a day	18 (56.3)	4 (30.8)	14 (73.2)	.24	7 (53.8)	2 (33.3)	5 (71.4)	.47	31 (47.0)	13 (32.5)	18 (69.2)	.38
Sedentary Behaviour N(%)												
Increase in TST	12 (37.5)	3 (23.1)	9 (47.4)	.22	5 (41.7)	1 (16.6)	4 (57.1)	.35	31 (47.0)	15 (37.5)	16 (61.5)	.47
Increase in sedentary transport	24 (75.0)	10 (76.9)	14 (72.9)	.05	8 (61.5)	3 (50.0)	5 (71.4)	.60	44 (66.6)	29 (72.5)	15 (57.6)	.19
Increase in total hobbies	22 (68.8)	9 (69.2)	13 (68.4)	.57	6 (46.1)	1 (1.9)	5 (71.4)	.13	44 (66.6)	25 (64.1)	19 (73.0)	
Increase in total sedentary behaviour	12 (37.5)	5 (38.5)	7 (36.4)	.30	2 (15.4)	1 (16.6)	1 (14.3)	.05	27 (40.3)	12 (30.8)	15 (57.6)	.32

Finally we used a logistic regression model to analyse what factors affect the abandon of sport participation and the reduction of MVPA during the studied years. We selected those predictors of change that, from the previous results, could greatly affect sport abandon and reduction of free time MVPA (Table 24).

On the one hand, when specifically looking in abandon of sport practice, we could find two significant (p=≤.10) predictors of change among males and two predictors of change among females. Females who gave up doing one sport during their free time significantly reduced their fruit and vegetables consumption (OR = .15; 95% CI =.02 - .99; p = .05) and failed to achieve the 300 minutes a week of MVPA (OR = .38; 95% CI = .13 – 1.08; p = .07). Meanwhile, males who gave up doing sport, significantly

increase their BMI (OR = 6.23; 95% CI =1.12 – 34.46; p=.07) and also failed to achieve the 300 minutes a week of MVPA (OR = .28; 95% CI = .08-9.77; p= .04) (Table 40). On the other hand, when we look for predictors of change among those individuals who reduced their MVPA during free time, we found three significant predictors of change among males and four predictors of change among females (Table 24).

Males who substantially reduced their MVPA during free time also increase their BMI (OR = .25; 95% CI = .05-1.29; p = .10), abandon their sports (OR = .21; 95% CI = .05-1.46; p = .10) and increased their perception of economic related barriers (OR = .21; 95% CI = .05-1.35; p = .10). One predictor of change coincided with females: sport abandon (OR = .18; 95% CI = .03-.97; p = .04); furthermore, in this gender the perceived barrier to have other interests, time spend for passive transport and time spent doing sedentary hobbies appeared also as significant predictors (OR = .20; 95% CI = .04-1.08; p = .06; OR = 4.12; 95% CI = 1.32 – 12.86; p = .01; and OR = .32; 95% CI = .09 – 1.16; p = .08) respectively. The overall percentage is high in both tables, but slightly higher when observing sport abandon (Tables 24 and 25*)*.

Table 24. *The likelihood of change from practicing one sport to not practicing from middle to late adolescence associated with baseline predictors of change divided by genders.*

	Males			Females		
Predictors of change	**OR**	**95% CI**	**Sig.**	**OR**	**95% CI**	**Sig.**
Alcohol consumption increase	1.18	.14-9.71	.87	5.5	.30 – 101.2	.24
Start smoking	.26	.01 – 3.49	.26	.52	.07 – 3.78	.52
Fruit and vegetable reduction	1.21	.17 – 8.47	.84	.15	.02 - .99	.05
BMI increase	6.23	1.12 – 34.46	.03	1.90	.59 – 6.15	.28
PA recommendations during free time decrease	.28	.08-9.77	.04	.38	.13 – 1.08	.07
Expensive facilities increase	2.31	.24 – 21.85	.46	1.39	.25 – 7.60	.70
No time barrier increase	.35	.05 – 2.48	.29	.57	.11 – 3.03	.51
Academic work barrier increase	1.32	.17 – 9.94	.78	.43	.06 – 2.81	.38
Other interests barrier increase	.46	.02 – 8.53	.60	.28	.04 – 1.69	.16
Screen time increase	2.69	.28 – 25.92	.39	.49	.09 – 2.57	.40
Sedentary transport increase	.54	.10 – 2.87	.11	.54	.08 – 3.43	.51
Total hobbies increase	2.77	.44 – 17.09	.27	1.46	.38 – 5.58	.57
Total sedentary time	.54	.10 – 2.87	.47	1.83	.50 – 6.62	.35

Overall percentage for males = 85.0%; R^2.33. Overall percentage for females = 82.8%; R^2 .26

Table 25. *The likelihood of change from achieving the recommendations of MVPA to not achieving from middle to late adolescence associated with baseline predictors of change, divided by genders.*

Predictors of change	**Males**			**Females**		
	OR	**95% CI**	**Sig.**	**OR**	**95% CI**	**Sig.**
Alcohol consumption increase	1.40	.38 – 5.15	.60	.62	.13 – 2.85	.53
Start smoking	.18	.006 – 5.43	.32	.78	.13 – 4.67	.79
Increase frequency smoking	.62	.06 – 6.13	.68	.60	.11 – 3.26	.55
Fruit and vegetable reduction	2.54	.62 – 10.29	.19	.81	.17 – 3.73	.79
BMI increase	.25	.05 – 1.29	.10	.49	.15 – 1.52	.21
Sport abandon	.21	.05 – 1.46	.10	.18	.03 - .97	.04
Expensive facilities increase	.21	.05 – 1.35	.10	1.26	.42 – 3.74	.67
No time barrier increase	.90	.21 – 3.93	.89	1.50	.29 – 7.60	.62
Academic work barrier increase	.69	.13 – 3.43	.65	.34	.06 – 1.95	.22
Other interests barrier increase	.56	.11 – 2.92	.49	.20	.04 – 1.08	.06
Screen time increase	1.48	.38 – 5.64	.56	1.11	.27 – 4.59	.87
Sedentary transport increase	2.86	.52 – 15.47	.22	4.12	1.32 – 12.86	.01
Total hobbies increase	.44	.12 – 1.55	.20	.32	.09 – 1.16	.08
Total sedentary time	1.26	.36 – 4.33	.88	.66	.21 – 2.05	.48

Overall percentage for males = 66.7%; R^2 .29; Overall percentage for females = 76.7%; R^2.25

Discussion

The study 3 aims (i) to identify changes in patterns of health related behaviours from adolescence to early adulthood and, (ii) to identify how sport participation in high school influence the adoption of other health-related behaviours (smoking; alcohol, fruit and vegetable consumption; sitting time) when adolescents reach university. The data gathered and the conclusions extracted help us to discover how health related behaviours change among the same group of participants from adolescence to early adulthood and, how sport participation and PA at leisure time influence in these changes. Specific sport promotion programs are needed to avoid MVPA reduction during leisure time through late adolescence and to avoid the acquisition of unhealthy habits among sport participants.

The first result of this study show a sharp decrease of METs spent at leisure time across the years, and, as a consequence, a substantial amount of participants who fail to achieve the 300 minutes of PA at leisure time when they are university students. This decline is especially accentuated among females. Although the pronounced decrease of METs spent at leisure time appear in all the subgroups (except for IS males), those participants who were not doing any sport in 2012 present the greatest reduction of METs at leisure time. Spanish studies already reported a decrease in leisure-time PA in both genders during this transition point (Molina-García et al., 2015), and, overall, several authors assumed the importance that sport participation has in western societies to maintain good levels of PA during adolescence and beginning of adulthood (Malina, 2001; Van Mechelen et al., 2000). However, in the

literature there is no evidence about how protective sport participation can be to minimize this decline of PA at leisure time among Spanish or Catalan adolescents during this transition period. The logistic regression model showed that reduction of MVPA at leisure time was significantly related to sport abandon, which may contribute to a substantial decline of total PA levels (Malina, 2001). In consequence, is important to consider: (i) the importance to promote different types and levels of sport participation, in order to motivate adolescents, especially those with lesser sportive skills, to be active after the school period (Malina, 2001). (ii) The significant association between MVPA reduction and the perception of economic related barriers among males is the ascertainment that late adolescents are influenced by the costs of the activity.

The second result of this study indicates that only 34% of the sample in 2012 and 26% of the sample in 2014 achieved the fruit and vegetables recommendations. Other studies from industrialized countries found similar results (Larson, 2007; Takaoka & Kawakami, 2013). In Catalonia, even lower prevalence of children and adolescents achieving the recommendations were found (8%) (Departament de Salut, 2015). This is a public health concern due to the importance of fruits and vegetables consumption in prevention of several diseases (Van Duyn & Pivonka, 2000) and the high tracking of fruit and vegetable consumption from adolescence to adulthood (Takaoka & Kawakami, 2013). This study indicates that sport participants are more prone to eat fruit and vegetables and sport abandon is significantly related with failing to achieve the fruit and vegetables recommendations among females. Similarly, some of the adolescents interviewed during the course of this research associated fruit and

vegetable intake with a better sport performance. In consequence, our results suggest (i) the importance to promote fruit and vegetable intake before puberty to avoid this low numbers when children reach adolescence and (ii) if promoted within sport context, sport participation may be beneficial for fruit and vegetable intake in adolescents and early adults.

The third result from this study indicates that participating in one sport during high school is not protective against males' alcohol consumption either during high school or later on, when adolescents reach university. As said before positive associations between alcohol consumption and sport participation have been reported across the literature (Lisha et al., 2010). Moreover, several studies reported that regular drinking increases through adolescence and early adulthood (Melchior et al., 2008), specially during the weekends, as found in Spain (Ruiz-Juan & Ruiz-Risueño, 2010). The present results found longitudinal associations between team sport participation and alcohol use. Team sport participants presented the highest prevalence of alcohol consumption and the highest frequency of consumption (drinking ≥ 1 beverage per week) in wave 1. Interestingly, when TS participants reached university, prevalence of consumption remained stable but frequency of consumption notoriously increased (32% (wave 1) to 46% (wave 3)). Considering that tracking of alcohol consumption is high among adolescent males who practice one sport during high school, efforts should be applied to avoid acquisition of alcohol consumption among male sport participants, starting before the 16 years old.

The fourth result of this thesis indicates that specific domains of sedentary time (other sedentary hobbies) notoriously increased during this age period. Other sedentary

hobbies (talking with friends, playing musical instruments, doing handicrafts and reading not for school) presented a sudden upsurge in wave 3. It could not be found longitudinal studies associating levels of PA and changes in inactive hobbies from late adolescence to early adulthood; however our results suggest that the decrease observed in MVPA at leisure time may be related to an increase of time spent in inactive hobbies, especially among females. We based this hypothesis in two main findings: (i) Among females, reducing MVPA levels at leisure is associated to the substantial increase of the perceived barrier: *to have other interests*. Other interests may be, as detected in the interviews, inactive hobbies. (ii) Not achieving the PA recommendations in 2014 is significantly associated to an increase of total inactive hobbies among females.

The fifth result from this study indicates that BMI increase is a predictor of change of MVPA decrease and sport abandon among males. The literature is consistent about how low levels of PA are related to higher risk of overweight and obesity (Janssen & Leblanc, 2010; Buchan et al., 2011) and high volumes of daily vigorous PA have been related to lower body fat (Lobstein & Frelut, 2003; Janssen et al., 2005) also in Spain (Ruiz et al., 2006). Although, the levels of BMI in our sample are, in general, low, and the physical changes occurred during adolescence and early adulthood may affected the BMI of the participants; the negative association between MVPA at leisure time and BMI, is a clear concern for future longitudinal research among late adolescents and early adults from Osona.

The final result from this study suggested that abandoning one sport during late adolescence may be associated to the acquisition of unhealthy lifestyles, a part from

the reduction of MVPA at leisure time. Previous research has suggested that adolescents with decreasing PA may increase their substance use (Audrain-McGovern et al., 2012), our results advise that the percentage of participants who reduced their fruit and vegetable intake and started smoking was higher between those who abandoned their sport participation.

Implications for Public Health

The present study analyses the health behaviours from a sample of Catalan teenagers and finds longitudinal associations between PA, sport participation and other health related behaviours (alcohol and tobacco consumption, fruit and vegetable intake and sedentary behaviour). On the one hand, the actual health plan from Catalonia proposes 2020 as a target to reduce the mortality due to NCDs (15%), by increasing 10% the people achieving the MVPA recommendations, reducing the prevalence of tobacco consumption under 28%, and reducing the prevalence of overweight and obesity below the actual levels (35.3% and 12.0%) (Departament de Salut, 2012). The results from this study indicate that: (i) strategies to achieve these aims need to be developed during adolescence and in some cases (fruit and vegetable intake and PA promotion programs) before adolescence; and (ii) special efforts are required during the transition point from adolescence to early adulthood, when health related behaviours tend to worsen.

On the other hand, health plans for Spain and Catalonia do not include any targets or actions to reduce sitting time behaviors (Departament de Salut, 2015). The high prevalence of sedentary behavior observed amongst the sample, emphasize the

importance to establish a consensus about specific targets aiming to reduce this emergent risk behavior that has been consistently linked to the development of several NCDs (Thorp et al., 2011). Moreover, the present results indicate the transition from high school to university as an appropriate period to propose an action plan, due to the substantial changes observed in the different patterns of sedentary behavior.

Limitations, future directions and conclusions

A part from the limitations detected in the previous study (study 2), there are new limitations that need to be considered. In wave 3, the students completed the same questionnaire from the previous two years by themselves. The moment when the survey was completed could also influence the answers of the subjects, although the questionnaire was available in Internet from March to June, the same months that we used to handle the questionnaire the previous years (2012 and 2013). The final number (n=180) does not seem big enough to extrapolate the results on a national basis, although it is a reasonable number considering that we followed up the same group of adolescents for three consecutive years. Another limitation encountered in this research is the impossibility to know the prevalence of binge drinking among the participants. According to the literature, knowing this prevalence would help us to deepen in the relationship between alcohol behaviour and sport participation. However, with the questionnaire used, we could not gather this information. Finally, my lack of expertise in statistical analysis was a hindrance when performing the

longitudinal analysis. However, a statistician from the University of Vic was available to help us with the main analysis.

Future studies

Our quantitative results point out the importance to know the motivations and circumstance that help some adolescents to keep on doing their corresponding sports. Perhaps, they have more facilities to keep with their trainings: more flexible hours of training or different venues to train, but this is information required for future research. The relationship between substance use and sport participation needs to be further investigated. The increase in specific sedentary behaviour domains during this age period seems relevant enough to put especial attention during future research. Further longitudinal research and qualitative research would be necessary to draw more conclusions about these topics.

Conclusions of the study 3

The sharp decrease of adolescents meeting the recommendations of PA at leisure time through late adolescence and early adulthood is a matter of concern. Participating in sports -particularly team sports- was associated to higher alcohol consumption and this association remain stable across the waves. Fruit and vegetable intake is low in all the adolescents, although sport participants tend to be closer to the fruit and vegetable recommendations. These results emphasize the importance of sport clubs (including coaches, venue and management team) providing a wide range of activities to promote health through PA and the acquisition and maintenance of health related behaviours during the transition from late adolescence to early adulthood.

CHAPTER 6.

JUSTIFICATION, LIMITATIONS, CONCLUSIONS AND FINAL THOUGHTS.

CHAPTER 6: CONCLUSIONS, LIMITATIONS AND FINAL THOUGHTS

Justification of the study place

This PhD thesis was focused on the youth population from a county of Catalonia: Osona. Osona is located in central Catalonia, 60 Km north of Barcelona, it has 51 different villages and cities, its capital is Vic, and its current population is 155.000 inhabitants (mean age = 39.5 years old), with a population growth of 1.54 (higher than the Catalan median = 1.45). (Institut d'Estadística de Catalunya (IDESCAT), n.d.).

The region of Osona (Barcelona) was selected for several reasons: (i) Osona is a hub for Catalonia due to its implications in promoting the Catalan culture and its representativeness in the Catalan sport context (Consell Català de l'Esport, 2005); (ii) based on regional data (Institut d'Estadística de Catalunya, n.d.) the amount of children of Osona is high (26.478 aged 0 to 14 years old); (iii) recent studies indicate a high prevalence of overweight and obesity among children from Osona (32.4%), emphasizing the need to create specific programs to increase PA among youth in this region (Coll, Mas, Salvador, & Terricabras, 2012); (iv) during the last 3 years several PA interventions for youth (i.e. entorn actiu and walking school routes) have been developed in Osona, revealing the importance that the public institutions from this region gives to PA promotion programs.

Taking into account that (i) studying specific target groups and cultural contexts is an efficient way to develop lifestyle interventions (Greaves et al., 2011; Sallis et al., 2008), (ii) the high prevalence of overwight and obesity observed in the children from this county, and (iii), the influence of Osona in the development of several aspects of Catalonia, including PA promotion programs; developing longitudinal descriptive data from a representative sample of adolescents from Osona to identify patterns and associations of PA, sport participation and health related behaviours is fundamental. This study, will not only inform Catalan policy-makers and public health specialists on how to develop effective strategies to prevent the adoption of unhealthy-related behaviours during adolescence and young adulthood, but will also inform regional policy on how to develop effective approaches to promote the health of the local youth.

Main limitations of the research

The 3 main limitations observed in this research are:

1. The high levels observed in some of the IPAQ-A domains such as, work/school and house, and the unrealistic levels of total PA levels when adding total METs, which were susceptible of over-reporting measurements, led us to use PA at leisure time as the main variable to find associations between PA and health related lifestyle behaviours. The use of 300 minutes of PA at leisure time as a threshold to achieve the PA recommendations during the longitudinal study may be another limitation. Taking into account that we were studying the

transition period from adolescence to adulthood which complicate selecting one of the two guidelines, we researched for different articles studying similar group of age and we selected 300 minutes of PA in accordance with previous research and current PA guidelines for adolescents (Dumith et al., 2010; Bastos et al, 2008; Hallal et al., 2006). Moreover, as said before, this threshold has been previously used on Spanish research looking for associations between screen time and PA among Spanish adolescents (Serrano-Sánchez et al., 2011), and 300 minutes/week of PA during leisure time has been proved having great benefits for health in both adolescents and adults (Sattelmair et al., 2011).

2. The use of self-reported questionnaires can produced a potentially biased response due to misinterpretations of time spend sitting (i.e. over-reporting or overlapping sedentary activities). Although all the questionnaires chosen had acceptable validity and reliability, in our study we had to omit two main sedentary behaviours: (i) sitting and listening to music, and (ii) sitting and using the mobile phone. After completing the analysis it was detected that these two behaviours produced an unrealistic total sitting time; in consequence, and based in several comments from the sample while they were completing the questionnaire, it was assumed that these two activities were performed while doing other tasks (i.e. using the computer, reading a book or sitting in class.) In consequence, analysis was focused in those behaviours that were independently performed.
3. Another main limitation from this research is the lack of specific variable measuring the prevalence of binge drinking among the participants. According to the literature, knowing this prevalence would help us to deepen in the

relationship between alcohol behaviour and sport participation. However, with the questionnaire used, we could not gather this information. In consequence, future research associating sport participation and alcohol consumption, should include this question in order to understand better how much, how often and, even, why sport participants, especially males, consume more alcohol than others.

Main conclusions of the research

This study was undertaken in the context of high inactivity levels, moderate to high prevalence of alcohol and tobacco consumption, low fruit and vegetable consumption and high sedentary behaviour in the Catalan population (Departament de Salut, 2015; Generalitat de Catalunya, 2008). This placed an urging priority on researching the prevalence and associations between these health related behaviours in order to create the basis for new strategies counteracting these negative trends. This study explored the associations between different health related behaviours in a group of adolescents followed from 14-15 to 18-19 years old. The study was particular relevant to this task because, as far as we know, this is the first longitudinal study conducted in Spain associating these health related behaviours from late adolescence to early adulthood.

Prevalence and tracking of sport participation and MVPA at leisure time from late adolescence to early adulthood

Study 1 reported very low levels of PA among a group of adolescents (n = 685; mean age=16.2 years old) from Osona (Catalunya). Females reported significantly lower levels of PA compared to males. This data reinforce the importance to promote PA programs from early ages to encourage the acquisition of an active lifestyle among children and early adolescents.

Study 2 and 3 provide evidence about the drastically reduction of PA levels at leisure time across late adolescence and early adulthood. From wave 1 to wave 3 there was a substantial reduce of adolescents achieving the 300 minutes a week of leisure time PA as well as adolescents practicing one sport. Study 3 associated these two variables suggesting that abandoning sport participation was a predictor of change for not achieving the 300 minutes a week of MVPA at leisure time in wave 3. In consequence, the decline of participants achieving the PA recommendations was even higher amongst those adolescents who were not doing any sport.

Our results suggest that, sport participation may be still protective against PA decrease from late adolescence to early adulthood, as found in previous research (Rangul et al., 2011), especially among females. To promote a wide range of structured and cost-effective activities appears as a potential target to counteract this decline of MVPA at leisure time.

Relation with previous research

Levels of PA become unstable in transitional phases and it is generally low or non-significant from childhood and adolescence to young adulthood (Telama, 2009). Similarly to our results, the evidence concludes that from 16 to 19 years old people reduce their PA levels (Rangul et al., 2011). Moreover, in the vast majority of studies conducted in industrialized countries, including Spain, when adolescents reach adulthood a big percentage of teenagers abandon their sport participation (Roman et al., 2006; Nebot et al., 2010). Boreham et al. (2004) suggested that during adolescence PA is organized and school based while early adulthood PA is likely to be more a matter of choice and potentially require more motivation because of a need to self-direct. Considering one of the main objectives reported in the Spanish Health National Plan: To reduce levels of physical inactivity among adolescents (Ministerio de Sanidad, servicios sociales e igualdad, 2015); it is important to promote the availability of various types of activities and facilities in youth sport (Kjønniksen et al., 2008) in order to widen the offer among those adolescents who are not playing any sport or who abandoned their sport participation and may remain inactive.

Taking home message

Although the prevalence of sport participation decreases from late adolescence to early adulthood, our findings suggested that sport participation may be still protective against the MVPA decline observed at leisure time during this transition period.

Sport participation and substance use

Our studies (1, 2 and 3) found a relationship between alcohol consumption and sport participation among amateur athletes, finding significant differences during the high school years between male sport participants and non-participants. In our studies, TS are closely related to alcohol consumption. Furthermore, frequency of alcohol consumption increased over time among TS males and decreased among those not playing any sport. The findings from the qualitative study suggested that when athletes are in a party they do not think about the negative consequences related to alcohol consumption. Moreover in some cases sport participation can favour alcohol consumption, either because athletes may have more social events or because the competitive nature of athletes who tend to be competitive even when counting the amount of alcohol drinks.

Interestingly, among females the association between sport participation and alcohol consumption is not as strong compared to males, in fact, the predictors of change indicated that those females who abandon sport had strong probabilities to increase their frequency of alcohol consumption.

In studies 2 and 3, tobacco consumption was higher among males doing a team sport, especially during high school. However it was difficult to clarify the reasons for this high level of consumption either in the longitudinal analysis or in qualitative research. More research is needed to explain the associations encountered between tobacco consumption and sport participants in Spanish adolescent males. The patterns observed among females suggest that inactive females and those who abandon their

sport participation (especially individual sport) have more chances to start smoking, although no significant results were found.

Relation with previous research

Lisha & Sussman (2010) found positive associations between alcohol consumption and sport participation on 22 out of 29 studies reviewed. On the one hand, likewise to our study, TS participation among males has been closely related to alcohol consumption in several cross-sectional and longitudinal studies (Wichstrom & Wichstrom, 2008; Moore & Werch, 2005; Eitle et al., 2003). On the other hand, sport participation is not often related with smoking in the literature (Terry-McElarth et al., 2011), and in general, active adolescents (including those from Spain) present a lower prevalence of tobacco consumption (Tercedor et al., 2007; Moreno at el., 2012; García et al., 2014). However, the athlete males from our sample contradict these findings. One hypothesis found in the literature was social activities and interests change across adolescence and, smoking and alcohol consumption in these contexts may be less problematic and even desirable (Amos & Bostock, 2007), which can incentive athletes to become more social smokers and drinkers.

Taking home message

Sport clubs (including coaches, venue and management team) have to put more effort to avoid the acquisition and maintenance of unhealthy habits (alcohol and tobacco consumption) among their athletes.

Sedentary behaviour and MVPA across late adolescence.

Our results indicate that during late adolescents the sample studied spend a mean of >11 hours per day (700 minutes) during the weekdays and >9 hours per day (550 minutes) during the weekends sitting for transport, in front of screen, in class, doing homework and doing sedentary hobbies. In general, males spend more time sitting than females. When observing the different domains of sedentary behaviour it was detected that: (i) Screen time is highly prevalent among the sample and tracks from late adolescence to early adulthood. Furthermore, screen time is significantly related to sport participation among females, because those who do not practice any sport generally spend more minutes a day in front of screen for non-educational reasons. Our results suggest that time spent at a screen may conflict with the available time to be active among late adolescence and early adults females. (ii) There is a substantial increase of time spend sitting as a way of transport through late adolescence and early adulthood. This happens both in males and females and independently of their sport participation; however, the increase of sedentary transport is a predictor of change of MVPA reduction among males. The interviews conducted suggest that when adolescents leave high school and start university, they change their trip routines, either because they use the car or the public transport to go to university. Importantly, the interviews conducted imply that those using the public transport spend more time walking than those who use their own car. (iii) Time spent sitting for hobbies (talking with friends, reading not for academic reasons, doing art crafts and playing instrumental music) significantly increased when adolescents reached adulthood. This increase was significantly associated with failing to achieve the PA recommendations

when females reached adulthood. The main increase observed in our research was in sitting and talking with friends.The quantitative results and the interviews told us that promoting active hobbies among late adolescents which can be done with their group of friends, is a target to reduce the prevalence of sitting behavior and the decline of PA observed during late adolescence and early adulthood. (iv) Finally, our results indicate that in high school, adolescents, independently if they are doing sport or if they are sufficiently active, spend over 400 minutes during a weekday (nearby 7 hours a day) sitting for academic reasons. When late adolescents reach the university this amount of minutes slightly decrease, but it is still high (≈ 350 minutes per weekday). Our finding suggests that academic work should be combined with promoting short bouts of PA during the day in order to avoid prolonged sitting among late adolescents.

Relation with previous research

The literature indicates that prolonged sitting time directly and negatively affects individuals' health (Owen et al., 2009). Sedentary behaviour is prevalent among adolescents and some behaviours like TV viewing, may track better than PA across adolescence and early adulthood (Biddle et al., 2010; Gordon-Larsen et al., 2004).

Previous findings have suggested an inverse relationship between sitting time and levels of PA (Bennie et al., 2013), supporting the hypothesis that total time spent in front of screens and/or doing other sedentary hobbies, is associated with reduced PA (Serrano-Sánchez et al., 2011). Considering that a high percentage of adolescent females in Europe exceed the American Academy of Pediatrics recommendations for

screen time (≥2h/day) (Rey-López et al., 2010) and the high enagement in social sedentary activities found in late adolescent girls (Reagan & Heary, 2011), our results suggest that time spent doing sedentary hobbies may conflict with the available time to be active among late adolescence and early adults females, reconsidering the displacement hypothesis among late adolescents (Mutz et al., 1993). On the other hand, being aware that active transport is a healthy lifestyle and may protect against risk of weight gain (Ding, Sugiyama, & Owen, 2012) the high increased observed of time spent in sedentary transport from adolescence into early adulthood (Coll et al., 2013; Chillon et al., 2011) is a matter of concern.

Finally, knowing all the mental and physical benefits that some PA towards the day bring to the individuals (Díaz-Martínez et al, 2011) and being aware that short bouts of PA during the day can help the adolescents to meet the healthy recommendations of PA (Barr-Anderson, 2011), the large amount of prolonged time Spanish adolescents spend sitting in class needs to be reconsidered.

Taking home message

Being aware that sedentary behavior is an independent behavior for health related problems, strategies to reduce prolonged sitting during adolescence should be promoted from different settings: families, schools, universities and communities.

Final thought

As proposed, the present thesis is the basis for further investigation. The lack of longitudinal studies encountered in Spain and Catalonia associating PA, sport participation and the health related behaviours studied in this research, give special relevance to this thesis. The present results may be used as a foundation to create new health promotion strategies, with the purpose to achieve the main aims established in the Catalan and Spanish National Health Plans.

Academic and professional achievements during the thesis.

3 years university lecturer in the University of Vic-Central University of Catalonia. Subject: Health and wellbeing promotion through PA. Students: 4th grade of Physical Activity and Sport Science Degree.

International internship in the Universidade Federal de Pelotas (UFPEL) (Brasil): During this internship (3 months) I participated in scientific group meetings, unit meetings and research projects always supervised by Professor Mario Azevedo. I actively participate in Educaçao Fisica+ doing an observational study during PE classes and recess time in different schools from Pelotas (appendix 19).

Participation in one published article: Azevedo, M. R., Menezes, A. M., Assunção, M. C., Gonçalves, H., Arumi, I., Horta, B. L., & Hallal, P. C. (2014). Tracking of physical activity during adolescence: the 1993 Pelotas Birth Cohort, Brazil. *Revista de Saúde Pública*, *48*(6), 925–930.

Participation in two international congresses: (i) 18th annual congress of the European College of Sport Science: Unifying sport sciences; hosted in Barcelona in 2013. (ii) 5th International congress on physical activity and public Health, promoted by the International Society for Physical Activity and Health (ISPAH), hosted in Rio de Janeiro in 2014 (appendices 20 and 21).

Organization of one international conference about public health: The conference was hosted in the University of Vic with 5 speakers talking about promoting PA and healthy diet in industrialized countries (appendix 22).

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