Active commuting to university in Chilean and Spanish university students: patterns and correlates

Ximena Palma Leal

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Active commuting to university in Chilean and Spanish university students: patterns and correlates

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Active commuting to university in Chilean and Spanish university students: patterns and correlates

Desplazamiento activo a la universidad en estudiantes Chilenos y Españoles: patrones y correlatos

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Tenemos una reserva insospechada de fuerza en el interior,

que surge cuando la vida nos pone a prueba.

Isabel Allende

Index

Title

Active commuting to university in Chilean and Spanish university students: patterns and correlates

Desplazamiento activo a la universidad en estudiantes Chilenos y Españoles: patrones y correlatos

List of abbreviations

PA	Physical Activity
MVPA	Moderate to Vigorous Physical Activity
EE	Energy Expenditure
METs	Metabolic Equivalents
SES	Socioeconomic Status
FAS	Family Affluence Scale
CPAA	Compendium of Physical Activities for Adults
IPAQ-SF	International Physical Activity Questionnaire- Short Form
IFIS	International Fitness Scale
BMI	Body Mass Index
SD	Standard Deviation
ANOVA	Standard Analysis of Variance
IQRs	Interquartile Ranges
Z-scores	Standardised scores
Beta	Unstandardized Beta coefficient
OR	Odd Ratio
95% CI	95% Confidence Intervals
SPSS	Statistical Package for the Social Sciences
GIS	Geographic Information Systems
PUCV	Universidad Católica de Valparaíso
UTFSM	Universidad Técnica Federico Santa María
UDLA	Universidad de las Américas
UCA	University of Cádiz
SDGs	Sustainable Development Goals
WHO	World Health Organization
OECD	Organization for Economic Cooperation and Development

Abstract

Adulthood is the longest stage of life, and the beginning of this period may be determined by university. In fact, 76% of young adults worldwide decide to continue their education at the age of 18, starting their vocational education in parallel with their continuing personal development. In this respect, and according to the evidence, university is a critical period of change, and potentially of new lifestyles. Unfortunately, this transition is linked to behaviours that affect health, notably a significant reduction in physical activity levels. This could be extremely important, as the behaviours adopted in this period play a role in the consolidation of lifelong patterns.

Active commuting to university has been studied as a potential strategy for increasing physical activity levels, as well as other valuable individual benefits, and also bringing environmental benefits. However, the use of active commuting depends on different factors that need to be studied and considered for its promotion.

Therefore, the overall objective of this International Doctoral Thesis was to analyse the patterns and correlates of active commuting to university in Chilean and Spanish students. This was addressed in three Sections with seven cross-sectional studies focused on: to explore commuting patterns, sociodemographic characteristics, physical activity, and physical fitness of university students in Chile (**Section I**); to explore commuting patterns, sociodemographic characteristics, physical activity, and physical fitness of university students in Spain (**Section II**); and to explore university lifestyle, barriers to active commuting and built environment in the university context of Chile and Spain (**Section III**).

The main findings of this International Doctoral Thesis suggest that:

1. Public and private transport were the main mode of commuting to and from university in Chilean and Spanish students, respectively, and could be influenced by different socio-demographic characteristics.
2. Commuting variables calculated from self-reported variables could provide a valuable proxy measure of physical activity during commuting among university students.

3. University students from Chile and Spain who actively commuted to university were more likely to have higher physical activity levels, and to report higher components of physical fitness, compared to those using motorised transport.
4. Walking approximately 7 min per trip (to or from university) could contribute to 44% weekly of the moderate to vigorous physical activity recommendations to obtain health benefits in university populations, as it involves the highest levels of energy expenditure per min, followed by public and private transport.
5. Behaviours such as sleep duration, daily breakfast, high physical activity levels, less sitting time, and active commuting to university may significantly influence higher components of physical fitness, which are powerful markers of health.
6. The barriers to active commuting were different and may be influenced by gender and the country context.
7. The built environment around campuses may affect the travel behaviours of university students.

In conclusion, the main results of this International Doctoral Thesis show that commuting patterns to university and their associated correlates could be of interest for future studies focusing on the health of the university population, as well as for future strategies in transport policies, to promote active and sustainable commute such as walking and cycling

Resumen

La edad adulta es la etapa más larga de la vida, y el comienzo de este periodo puede estar determinado por la universidad. De hecho, un 76% de adultos y adultas jóvenes de todo el mundo decide continuar sus estudios a los 18 años, dando inicio a su formación profesional en paralelo con su continuo desarrollo personal. Con respecto a esto y de acuerdo con la evidencia, la universidad es un periodo crítico de cambios, y potencialmente de nuevos estilos de vida. Lamentablemente, esta transición está vinculada a comportamientos que afectan la salud, sobre todo por una reducción significativa de los niveles de actividad física. Esto podría ser extremadamente importante, ya que los comportamientos adoptados en este periodo juegan un papel clave en la consolidación de patrones para toda la vida.

El desplazamiento activo a la universidad se ha estudiado como una potencial estrategia para aumentar los niveles de actividad física, así como otros beneficios individuales de gran valor, además de aportar beneficios medioambientales. No obstante, el uso del desplazamiento activo depende de diferentes factores que deben ser estudiados y considerados para su promoción.

Por lo tanto, el objetivo general de esta Tesis Doctoral Internacional fue analizar los patrones y correlatos del desplazamiento activo a la universidad en estudiantes Chilenos y Españoles. Este fue abordado en tres Secciones con siete estudios transversales centrados en: explorar los patrones de desplazamiento, las características sociodemográficas, la actividad física y el estado físico de los y las estudiantes universitarios/as en Chile (**Sección I**); explorar los patrones de desplazamiento, las características sociodemográficas, la actividad física y la condición física de los y las estudiantes universitarios/as en España (**Sección II**); y explorar el estilo de vida universitario, las barreras al desplazamiento activo y el entorno construido en el contexto universitario de Chile y España (**Sección III**).

Los principales hallazgos de esta Tesis Doctoral Internacional sugieren que:

1. El transporte público y el privado fueron el principal modo de desplazamiento hacia y desde la universidad en los estudiantes Chilenos y Españoles respectivamente, y podrían estar influidos por diferentes características sociodemográficas.
2. Las variables de desplazamiento calculadas a partir de variables auto informadas podrían proporcionar una valiosa medida indirecta de la actividad física durante el desplazamiento entre los y las estudiantes universitarios/as.
3. Los y las estudiantes universitarios/as de Chile y España que se desplazaban activamente a la universidad tenían más probabilidades de tener un nivel más alto de actividad física y de informar niveles más altos de los componentes de la condición física, en comparación con los que utilizaban transportes motorizados.
4. Caminar aproximadamente 7 minutos por trayecto (hacia o desde la universidad) podría contribuir al 44% semanal de las recomendaciones de actividad física moderada a vigorosa para obtener beneficios para la salud en población universitaria, ya que implica los mayores niveles de gasto energético por minuto, seguido del transporte público y privado.
5. Comportamientos como la duración del sueño, el desayuno diario, los altos niveles de actividad física, el menor tiempo sentado y los desplazamientos activos a la universidad pueden influir significativamente en los componentes de la condición física, que son potentes marcadores de salud.
6. Las barreras a los desplazamientos activos a la universidad fueron diferentes y pueden estar influidas por el género y el contexto del país.
7. El entorno construido alrededor de los campus puede afectar a los desplazamientos de los y las estudiantes universitarios/as.

En conclusión, los principales resultados de esta Tesis Doctoral Internacional muestran que los patrones de desplazamiento a la universidad y sus correlatos asociados podrían ser de interés para futuros estudios centrados en la salud de la población universitaria, así como para futuras estrategias en políticas de transporte de promoción de desplazamientos activos y sostenibles como caminar y andar en bicicleta.

INTRODUCTION

University context

Since 1960, demographic trends towards longer time in education and later age of entry into work, marriage and parenthood have led to the rise of a new life stage at ages 18–29 years, now widely known as emerging or young, adulthood in developmental psychology (Arnett et al., 2014), which mainly takes place at the university. Since then, different ideas about the university continued to hold sway and drive university education policy and spread across different countries. In fact, it was in the mid-20th century when the right to higher education for the entire population radically conditioned the development of this institution, which led to the massification of universities (Ruiz-Corbella et al., 2019). Indeed, according to the Organization for Economic Cooperation and Development (OECD) (OECD, 2023) a significant percentage of young adults worldwide decide to attend university (e.g., 89% in Belgium, 80% in Spain, 78% in Korea, 71% in Australia and the US, 69% in the UK, 65% in Chile), and it is predicted that by 2040, 600 million students worldwide will be enrolled in a university, a 200% increase from current numbers (Calderon, 2018).

Since their inception, universities have had as their main objective the intellectual and professional training of their students; however, in accordance with the demands and transformations of the present, their responsibility extends much further (Ruiz-Corbella et al., 2019). For instance, some of the demands include that universities must become leaders in educating for sustainable development goals (SDGs), which are a call to action by all countries to promote prosperity and protect the planet (UNESCO, 2016). Consequently, even if they are adults, it is important to consider that university students are in a formative educational process, which means that the training should be comprehensive and not only academic. This makes sense, since the university period is often characterised by lifestyle behaviour changes (Memon et al., 2021) and because of this, several studies have indicated that university students are a particular population vulnerable to the development of inappropriate lifestyle behaviours (Deforche et al., 2015; Deliens et al., 2014; Liu et al., 2019). In effect, an increasing number of universities are taking into account the education of healthy lifestyle behaviours in their programmes, based on elective subjects (Mainegra et al., 2015) or compulsory programmes (Mamurov et al., 2020), but only for a few semesters.

Due to the increasingly accelerated changes in university life and the fact that some habits acquired in this period may persist into adulthood and may have a negative impact on their short- and long-term health (Dunne & Somerset, 2004), these trends are indications that research is needed in the university population, for possible training programmes on healthy lifestyle behaviours throughout the university period.

Student characteristics: lifestyle changes

Lifestyles can be modified by the social, economic, cultural and psychological changes that people face throughout their lives. University life is a fundamental change in the development of the human being, as it means making a decision about one's professional training that can determine one's future socio-economic conditions (Diez & López, 2017). Attending university is a steppingstone to independence, where students have the possibility to explore new cities, interests and/or routines, and need to learn how to manage them. For instance, in this period, students have more financial management, independence in their decisions, and less family supervision, since they often leave home and alter their schedules, among other changes. This can influence their lifestyle behaviours, leading to problems that may be reflected in their health status and, in turn, affect their academic performance. In fact, according to the evidence, one of the main concerns of the university is that is seen as a critical period for developing new lifestyles (Maillet & Grouzet, 2023), in particular towards less healthy lifestyle behaviours (Winpenny et al., 2020).

In this context, there is one health marker par excellence that could be an indicator of lifestyle behaviours in the university population, as well as in different populations (children, adolescents, adults, and/or older adults) (Donnelly et al., 2016; Monteagudo et al., 2021; Myers et al., 2019). This is *physical fitness* (especially cardiorespiratory fitness and muscular strength), which makes reference to a full range of physiological and psychological qualities (Ortega et al., 2008). In general, physical fitness has been studied in relation to both health and performance but, focused on the study population and the aim of this Thesis, will be addressed in relation to health.

A key aspect of the maintenance of physical fitness, and consequently health, could be different lifestyle behaviours, such as physical activity (PA), sitting time, sleep duration and eating habits. At this point, thinking about the changing lifestyles of university students, this may mean that this population is more likely to decrease their physical fitness, and as a result, have poorer health. Therefore, there is a need to understand in more detail the different lifestyle behaviours mentioned above focused on this young population for possible future actions.

In the scientific literature, the most studied behaviours are related to the activity intensity levels of the population and are *PA and sitting time*. This is due to the fact that the benefits of increasing regular PA and reducing sitting time decrease the risk of obesity, diabetes, hypertension (Guo et al., 2020), cardiovascular diseases (Tunaiji et al., 2019), and different types of cancer and mortality (Cannioto et al., 2018; Cong et al., 2014), and have been studied and are evident in all populations.

On one hand, PA, refers to any movement of the body that requires more energy than rest, has established protective effects on health, and its potential benefits span across the prevention, management, and treatment of several diseases (Stamatakis et al., 2019), and has been linked to life satisfaction and happiness (An et al., 2020). For instance, current systematic reviews and meta-analyses in a young population (children and adolescents) of more than 130 studies (Farooq et al., 2020; Smith et al., 2019), as well as in adults and older adults of more than 60 studies (Cunningham et al., 2020; Jakicic et al., 2019), has shown consistent associations between high levels of moderate to vigorous PA (MVPA) with different health outcomes. However, the largest part of the world's population is physically inactive (Kljajević et al., 2021), being the fourth leading cause of death worldwide (Andersen et al., 2016), making it a public health problem and described as a pandemic that needs urgent action.

On the other hand, with regard to sitting time, which refers to the lower end of the PA spectrum (Tremblay et al., 2017), evidence has indicated that limiting daily sitting time for major activities is associated with a lower risk of mortality from all causes and from cardiovascular disease (Katzmarzyk et al., 2009). However, it is important to noted that prolonged sitting time is a ubiquitous fact of life in modern society, especially in adults (Katzmarzyk & Lee, 2012). As a consequence, research has focused on the significant public health benefits of limiting excessive sitting time but replacing it with more PA (Dempsey et al., 2020). In fact, a systematic that included 13 studies showed that increased sitting time is associated with increased all-cause mortality, however, the magnitude of increased risk with increased sitting time is substantially attenuated or even eliminated in physically active people (Ekelund, 2018).

Focused on the study population of this Thesis, the panorama is no different. Despite the fact that the evidence is less, PA has been positively associated with health in university population, and a better quality of life (Kotarska et al., 2021; Krzepota et al., 2015), such as better physical, social, and mental health outcomes (Vankim & Nelson, 2013). Nevertheless, it has been reported that university students have lower levels of PA compared to the general adult population (Guthold et al., 2018). The first and only systematic review of PA prevalence in university students carried out in 2004, which included 19 studies (published between 1985-2001), indicated that a large majority of university students were not physically active (e.g., ≥50% in North America and China, 40% in Australia and 67% in Europe) (Irwin, 2004). Subsequent to this, international data on PA in the university population continues to show that more than half of the students do not meet the MVPA recommendations, regardless of their country of origin (Mella-Norambuena et al., 2019). In fact, studies in Chile (Rodríguez et al., 2013) and Spain (Arias-Palencia et al., 2015) have shown that the majority of university students (both, more than 70%) are physically inactive. This fact is having a direct impact on increases the risk of many adverse health conditions (Haileamlak, 2019; Lee et al., 2012; Pratt et al., 2014). In addition, with regard to sitting time, this sedentary behaviour has been associated with a higher risk of cardiometabolic diseases and mortality in university population (Patterson et al., 2018), as well as stress, anxiety, and depression (Lee & Kim, 2019). Alarmingly, a current systematic review shows that sitting time has increased over the last 10-year period among university students, and a considerable proportion of this population spends more time sitting than their young adult (non-student) peers (Castro et al., 2020). These rates, together with low levels of PA, are a major problem for this population.

In line with the above, the World Health Organization (WHO) recommendations on PA for adults indicate that adults should engage in a combination of MVPA, characterised by an energy expenditure (EE) between 3.0–5.9 and ≥6.0 metabolic equivalents (METs), respectively (Haskell et al., 2007), for 150–300 min of moderate-intensity PA or 75–150 min of vigorous-intensity PA, throughout the week to obtain substantial health benefits. However, WHO recommendations related to sitting time, characterised by an EE ≤1.5 METs (Tremblay et al., 2017), have not been possible to specify a quantitative threshold for the amount of time spent sitting due to insufficient evidence. The recommendations support the notion of moving more and sitting less, and this has been an important addition to the new global health guidelines (Bull et al., 2020). Therefore, it is clear that the university population needs strategies to reduce sitting time while increasing PA levels for their benefit.

Another important behaviour studied in the literature are the sleep disorders, such as restricted *sleep duration*. Sleep duration is among the numerous factors that can potentially influence physical health (e.g., PA) (Bauman et al., 2012), and mental health (e.g., depression) (Zhai et al., 2015). In addition, it has been studied in young (Felső et al., 2017) and adult (Bacaro et al., 2020) populations that restricted sleep duration was significantly associated with obesity. In contrast, a systematic review of previous meta-analyses in adults and older adults shows potential benefits of PA on sleep disorders (Kelley & Kelley, 2017). According to the young adults, university students have reported a chronically restricted sleep duration, less than the 7-9 hours recommended for young adults (National Sleep Foundation, 2020), which could potentially increase anxiety and depressive symptoms, affecting their general health conditions (Peltzer & Pengpid, 2016), mental health (Becker et al., 2018) and academic performance (Suardiaz-Muro et al., 2020). In addition, studies focused on sleep disorders and PA in university students shows a positive association between sleep duration and PA (Memon et al., 2021; Peltzer & Pengpid, 2016). For instance, some authors indicated that getting enough sleep for ≥4 days per week predicted 22.8% variance in meeting the MVPA recommendations in university students (Dinger et al., 2014). This is a great sign of how the different life changes of university students can relate to each other, as well as affect each other.

Last but not least, the worldwide prevalence of overweight and obesity has increased epidemically during the last decennia (von Ruesten et al., 2011). The WHO defines overweight and obesity as abnormal or excessive fat accumulation that presents a risk to health, and rates continue to grow in children and adults (WHO, 2023). For the same reason, the eating habits of the population have been a highly studied behaviour nowadays. For instance, it has been reported that today's society consumes many foods for the sake of pleasure, and not only because of the need for sustenance (Romero-Blanco et al., 2021). Also, behaviours have been studied in relation to food intake or not, such as the night eating syndrome, or skipping breakfast, which have been associated with weight gain (Ma et al., 2020; Meule et al., 2014).

The *breakfast status* is one of the significant meals for the human-beings. A person without breakfast will not have enough energy to start a morning task because it is the first meal taken after dinner with a long fasting interval (Rani et al., 2021). In fact, the risk of obesity in children and adolescents who skipped breakfast was 43% greater than those who ate breakfast daily (Ardeshirlarijani et al., 2019). In line with young adults, a study of university students from 28 countries showed that skipping breakfast is a health risk associated with being overweight or obesity, tobacco use, depression, sleep problems and poor academic performance (Pengpid & Peltzer, 2020). Therefore, the identification of regular breakfast consumption could be important to strengthening other healthy behaviours among the young adult population.

Against the above scenario, there is a behaviour that has been explored and could be a potential strategy to increase PA levels, reduce sitting time, and balancing behaviours such as sleep duration and eating habits, which would bring not only valuable individual benefits (e.g., improving physical fitness), but also environmental benefits (e.g., reducing air pollution). The behaviour being referred to is *active commuting,* and has been indicated as a possible key to the global initiative to promote active living for its benefits (Shephard, 2008).

In general, this behaviour has been studied highly and mainly in children and adolescents, followed by the adult working population, however, the evidence in the university population is more limited. Therefore, studies that contribute to expanding the evidence in these young adults will contribute information for possible future interventions in this area.

Active commuting to university: a potential strategy

Definition

Active commuting, understood as an ecological and frequent travel from one place to another by the physical effort of a person, could be an important contribution for a more active lifestyle in all populations. Sadly, of the limited evidence to date on the transition from secondary education to university, it has been observed a significant decline in the prevalence of active commuting to university (Larouche et al., 2020).

There are many forms of active commuting (including rowing boats, skateboards, or scooters), but for most people, the most common choice is walking and cycling (Shephard, 2008). Therefore, most of the evidence of active commuting, as well as this Thesis, has focused on these two modes of commuting.

The differentiation between active commuting and non-active commuting modes is the fact that these last ones are motorised, that is private transport (e.g., car or motorbike) and public transport (e.g., public bus, metro and train). Most of the studies to date, identify these both motorised modes in the same category, as passive or motorised modes (Henriques-Neto et al., 2020), however, there are different health, environment, and social implications between public and private transport that need to be considered, and contrasted to active commuting. In this line, studies suggest that active commuting should be prioritised, however, if the use of motorised transport is the only option (for instance, due to distance), the public transport services have the potential to be more active and sustainable compared with private transport (Nieuwenhuijsen & Khreis, 2016; Redman et al., 2013).

Benefits

As mentioned in a literature review, there are a number of potential health effects if the opportunity to incorporate active commuting into daily life is taken (van Schalkwyk & Mindell, 2018). Various studies, and consequently, systematic reviews, and meta-analyses, mostly on young (children and adolescents) and working adult populations, have been conducted on the health benefits of active commuting. For instance, a systematic review and meta-analysis shows that people who engaged in active commuting had a significantly reduced risk of all-cause mortality, cardiovascular disease incidence and diabetes (Dinu et al., 2019). In addition, a current systematic review shows that of the 16 included studies (11 in children and adolescents and five in adults) studies have shown a positive relationship between active commuting and several attributes of physical fitness, especially in adults (Henriques-Neto et al., 2020).

The potential health effects mentioned above are due to the fact that the evidence of active commuting has been developed especially in terms of the levels of PA involved. For instance, a systematic review and meta-analysis showed that active commuting to school may contribute about 48% of the MVPA recommendations in young people if both trip directions are actively performed (Campos-Garzón et al., 2023). In addition, a systematic review indicated that active commuting to work, even at a self-paced intensity, has a positive impact on MVPA levels, physical fitness and health outcomes (Schäfer et al., 2020). These higher MVPA levels in active commuting could be an important contributor to PA recommendations (Audrey et al., 2019), which would be reflected in health benefits (Bull et al., 2020), such as obesity prevention, a healthier metabolic profile (Martin-Moraleda et al., 2022; Steell et al., 2018), and less detrimental changes in the brain (associated with dementia later in life) (Torres et al., 2021). From the lesser evidence on active commuting to university, it has been suggested that this behaviour does indeed contribute to increase the PA levels among these young adults (Barranco-Ruiz et al., 2019; García-Hermoso et al., 2018; Rissel et al., 2013), but the lack of previous studies examining the impact to the MVPA recommendations, make their contribution imprecise.

It is important to note that active commuting not only offers individual benefits, such as increased PA and its associated physical, social and mental health advantages, but also contributes to sustainable development benefits, such as the reductions greenhouse gases, air pollution, traffic congestion, car dependency, noise, and temperature, in contrast to motorised transport, such as public transport, and even more so to private transport (Nieuwenhuijsen & Khreis, 2016; Sallis, et al., 2016). In fact, it has been stated that promote active commuting, even public transport, can give rise to contributing to two goals of the SDGs, goal 3 (ensure healthy lives and promote well-being for all at all ages), and goal 11 (make cities inclusive, safe, resilient and sustainable) (Neshovski, 2021).

Therefore, strategies that encourage university students to active commute have the potential to not only to improve the health of the students in particular, but also to reduce the impact on the environment. For the same reason, one of the greatest challenges is to prevent the decrease of active commuting and instead to increase it. In order to achieve this, it is essential to study different factors that may have an influence.

Correlates

It is important to consider that active commuting may be influenced, following the ecological model, by individual, social, community, environment, and policy factors (Larouche & Ghekiere, 2018). However, the relationship between active commuting and each of these factors in the university population remains unclear to date due to the limited evidence available.

Based on what different authors have researched, previous studies have indicated that examining the sociodemographic characteristics related to active commuting to university provides an empirical basis for interventions that could be implemented by universities to increase active commuting, but further research is needed on this issue among the university population, as it is not widespread (Barranco-Ruiz et al., 2019). In this regards, university students from USA indicated that the mode of commuting choice is influenced by their type of residence (e.g., family or university residence) (Zhou, 2012), while in Chile by gender and commuting time (Castillo-Paredes et al., 2021). In Spain, a study conducted at the University of Valencia showed that younger students, with lower socioeconomic status (SES), and who lived close to faculties were more likely to use active commuting modes than their counterparts (Molina-García et al., 2014). As a consequence of the different results, which might be due to specific characteristics of the cities and their citizens, each community should be considered independently, even if they belong to the same country, and should be treated individually for future actions.

In addition, it is important to consider more factors, which could influence an active choice to commute to university. For instance, it has been stated that providing adequate planning/psychosocial and environmental/safety factors is necessary to promote active commuting (Ferrari et al., 2020; Redman et al., 2013). But to date, little evidence of this has been observed in university population.

It can be suggested that aspects based on the personal decision to move actively play a more important role than the barriers imposed by the environment (Castillo-Paredes et al., 2021). However, it has also been studied that the presence and better quality of facilities in the city were positively related to the use of active commuting in the university population (Molina-García et al., 2010).

In this line, different factors and strategies have been considered around the world to create robust environments to enable a more active population (Nau et al., 2023). Evidence shows that the built environment, understood as the opposite of the natural environment, i.e., human-made components of people's surroundings (Younger et al., 2008), appears to be one of the main factors influencing a more physically active society (Sallis, et al., 2016), especially in adults (Ferdinand et al., 2012). In fact, a current systematic review including seven studies from the US, UK and China showed that interventions for friendlier built environments are especially useful for increasing MVPA among adults through the use of active commuting vs. motorised transport (Barradas et al., 2022). Considering the daily interaction between university students and their campuses, understood as enclosed land with buildings, i.e., faculties, administration, belonging to a university, and their built environment around, the situation could be the same.

The built environment have been scarcely analysed among university students (Molina-Garcia & Queralt, 2017). Only six studies around the world have studied the built environment of university campuses in relation to the active commuting of university students. For instance, studies from USA report the importance of built environment in differences in travel (e.g., active mode choices) and in commuting-related PA (Horacek et al., 2018; Sisson et al., 2008). In support of this, studies have been carried out in different cities in Asia and showed that different features such as density, connectivity, land-use mix, or services, can have important effects on PA levels, mainly through travel behaviours, e.g., walking (Lu et al., 2022; Ramakreshnan et al., 2020) or cycling (Chevalier et al., 2019), and even increase the physical fitness (Sun et al., 2014) of students. This type of reporting can be a step towards improving public policy and legislation to benefit the health of these young adults, as well as the entire university community. However, due to the lack of knowledge on this topic, the initial creation of such policies and legislation, seem distant. Adding more information in the literature on this issue is indispensable.

Although both the benefits and the correlates need further evidence and may still be inconclusive, **Figure 1** presents an indicative overview of what the literature so far indicates in relation to active commuting to university.

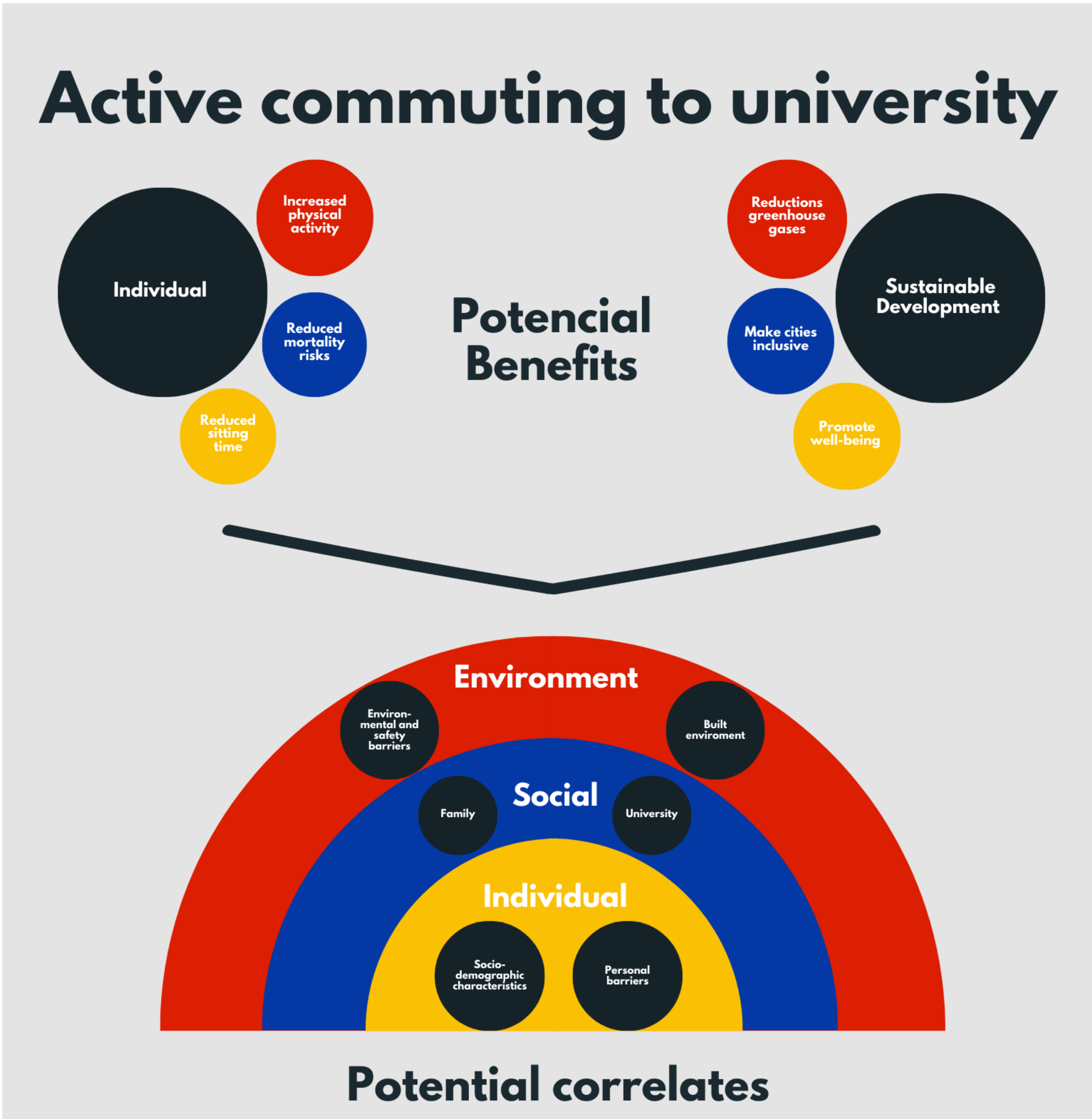

Figure 1. General outline of the benefits and correlates of active commuting to university.

Notes: The Figure is based on the theoretical background provided above.

International Doctoral Thesis Structure

The present International Doctoral Thesis focuses on active commuting to university in two countries, Chile and Spain, and the different lifestyle behaviour and correlates previously covered. The Thesis will be developed through a total of seven studies, grouped into three Sections. The **Section I** contain two studies with data from Chilean university students, the **Section II** contain two studies with data from Spanish university students, and **Section III** contain three studies with data from Chilean and Spanish university students combined.

AIMS

Overall Aim

The overall purpose of this International Doctoral Thesis was to analyse the patterns and correlates of active commuting to university in Chilean and Spanish students.

Specific Aims

Section I: Commuting patterns, sociodemographic characteristics, PA, and physical fitness of university students in Chile

Study 1: to describe the commuting patterns to and from university and sociodemographic characteristics regarding gender, to provide new commuting variables calculated from self-reported variables to proxy measure of PA during commuting, and to examine the sociodemographic characteristics associated with commuting variables regarding gender.

Study 2: to describe the mode of commuting, PA and physical fitness in university students by gender; to analyse the associations of mode of commuting with PA and physical fitness by gender; and to examine the relationship between mode of commuting, MVPA recommendations and physical fitness by gender.

Section II: Commuting patterns, sociodemographic characteristics, PA, and physical fitness of university students in Spain

Study 3: to describe the commuting patterns to and from university, sociodemographic characteristics, PA levels, and physical fitness by gender, and to analyse the associations between the mode of commuting with sociodemographic characteristics, PA levels, and physical fitness by gender.

Study 4: to describe and compare self-reported and device-measured in commuting variables, PA, and sitting time to and from university by the mode of commuting per weekday, and to identify associations between self-reported and device-measured of commuting variables, PA, and sitting time.

Section III: University lifestyle, barriers to active commuting and built environment in the university context of Chile and Spain

Study 5: to identify different lifestyle behaviour patterns in university students regarding sleep duration, breakfast status, PA levels, and the mode of commuting, and to determine the associations of cardiorespiratory fitness and muscular strength with the different lifestyle behaviour patterns established.

Study 6: to examine the differences in the mode of commuting and barriers to active commute to university among gender and country, and to analyse the association between the mode of commuting and the perceived barriers for men and women Chilean and Spanish university students.

Study 7: to describe and to explore the built environment features around six university campuses associated with active commuting of university students, separately by country.

OBJETIVOS

Objetivo General

El objetivo general de esta Tesis Doctoral Internacional fue analizar los patrones y correlatos del desplazamiento activo a la universidad en estudiantes Chilenos/as y Españoles.

Objetivos Específicos

Sección I: Patrones de desplazamiento, características sociodemográficas, actividad física y condición física de los y las estudiantes universitarios/as en Chile

Estudio 1: describir los patrones de desplazamiento hacia y desde la universidad y las características sociodemográficas en relación con el género, proporcionar nuevas variables de desplazamientos calculadas a partir de variables auto reportadas para obtener una medida estimada de la actividad física durante los desplazamientos, y examinar las características sociodemográficas asociadas a las variables de desplazamientos calculadas en relación con el género.

Estudio 2: describir el modo de desplazamiento, la actividad física y la condición física de los estudiantes universitarios/as en función del género; analizar las asociaciones del modo de desplazamiento con la actividad física y la condición física en función del género; y explorar la relación entre el modo de desplazamiento, las recomendaciones de actividad física moderada a vigorosa y la condición física en función del género.

Sección II: Patrones de desplazamiento, características sociodemográficas, actividad física y condición física de los y las estudiantes universitarios/as en España

Estudio 3: describir los patrones de desplazamiento hacia y desde la universidad en estudiantes españoles, las características sociodemográficas, los niveles de actividad física y la condición física en estudiantes universitarios/as españoles según género, y analizar las asociaciones entre el modo de desplazamiento con las características sociodemográficas, los niveles de actividad física y la condición física según género.

Estudio 4: describir y comparar las variables de los desplazamientos auto reportados y medidos con dispositivos, la actividad física y el tiempo sentado hacia y desde la universidad según el modo de desplazamiento a la universidad por día de la semana, e identificar las asociaciones entre las variables de desplazamiento auto reportadas y medidas con dispositivos, la actividad y el tiempo sentado.

Sección III: Estilo de vida universitario, barreras al desplazamiento activo y entorno construido en el contexto universitario de Chile y España

Estudio 5: identificar diferentes patrones de comportamiento en el estilo de vida de los estudiantes universitarios/as en relación con la duración del sueño, el estado del desayuno, los niveles de actividad física y el modo de desplazamiento a la universidad, y determinar las asociaciones de la condición física cardiorrespiratoria y la fuerza muscular con los diferentes patrones de comportamiento en el estilo de vida establecidos.

Estudio 6: examinar las diferencias en el modo de desplazamiento y las barreras para el desplazamiento activo a la universidad entre géneros y países, y analizar la asociación entre el modo de desplazamiento y las barreras percibidas por los/as estudiantes universitarios/as Chilenos/as y Españoles.

Estudio 7: describir y explorar las características del entorno construido en torno a seis campus universitarios asociadas a los desplazamientos activos de los/as estudiantes universitarios/as, según país.

METHODS

Data Collection

The data from the seven cross-sectional studies were conducted between April and November of 2017 in Chile and May 2018 in Spain, during normal class periods. The data collection was completed through self-reported (questionnaire) in the total sample (Section I, II and III, all studies), and device (accelerometer) in part of the sample (Section II, Study IV).

Considering that the ethical requirements, procedures, as well as the study variables used were the same in all studies, these will be explained below. Subsequently, the description of the samples, the study variables and the statistical analyses used in each of the studies will be provided by Sections.

Ethical Requirements

To initiate this Thesis, approval was obtained from the Ethics Committee of Pontificia Universidad Católica de Valparaíso (PUCV) (Code: CCF02052017) (**Annexes I**), and from the Ethics Committee for Non-Biomedical Experimentation and evaluation of experimentation with Genetically Modified Organisms at the University of Cádiz (UCA) (Ref. 004/2021) (**Annexes II**). In addition, all studies were carried out following the Helsinki protocols, considering the statement of ethical principles for research involving human subjects.

Procedures

Firstly, a letter with the objectives of the study was sent to the authorities of the selected universities in Chile and Spain, chosen by convenience. Once the authorities' authorization was obtained, all the participants were invited to voluntarily participate. They received information about the study, and those who agreed to participate completed and signed an informed consent. The informed consent explained the purpose of the study, the characteristics of the questionnaire and the confidentiality of the results. The participants completed a 15 to 30 minutes self-reported paper-based (Chile) and online-based (Spain) questionnaires that were distributed and guided by previously trained volunteer teachers, in both countries.

Study variables

Most of the variables used for this International Doctoral Thesis were based on a self-reported questionnaire created at the School of Physical Education of the Pontificia Universidad Católica de Valparaiso by researchers, based on a literature review and consultations with experts. The questionnaire, called Questionnaire of mode of commuting and PA in university students, includes study variables about commuting patterns, sociodemographic characteristics, PA and sitting time, barriers to active commuting, sleep duration, breakfast status, and physical fitness (**Annexes III**). All questions were adapted to the country context appropriately.

In addition to self-reported measurements, device measurements of PA and sitting time, as well as assessment of body composition, and the built environment features of university campuses were performed. All the study variables will be explained below.

Commuting Patterns

Mode of commuting

The mode of commuting to and from university was assessed using separate questions: How do you usually travel to university? and, how do you usually travel from university? The answer options were walking, cycling, car, motorcycle, public bus, metro/train, and others. Participants had two different groupings depending on the study. The first classification had three categories: active commuting (walking and cycling), private transport (car and motorbike) and public transport (public bus, metro and train). The second classification had two categories: active commuting (walking; cycling) and motorised transport (public: public bus, metro, train; and private: car, motorcycle). For both classifications, the participants with combined answers (e.g., active + private) were classified in the mode of commuting involving the highest PA levels, from active commuting (involving the highest PA levels), followed by public transport (involving walking to the stops), to private transport (involving the lowest PA levels) (Rissel et al., 2012).

The mode of commuting to and from university showed an almost perfect agreement in both countries (with Kappa coefficient values of 0.882 and 0.822 in Chile (Palma-Leal et al., 2020), and 0.929 and 0.930 in Spain).

Other commuting variables

Five other commuting variables were considered: commuting time, commuting distance, commuting speed, and two commuting EE: per minutes and total. The first two variables were self-reported by participants, and the other three variables were calculated. Further details of the five commuting variables will be explained below one by one.

Commuting time was assessed using the question: How long does it take to go from home to university? Participants indicated the minutes per day dedicated to each mode of commuting to and from university from Monday to Friday. These minutes were separated according to the category of mode of commuting.

The commuting distance to and from university was assessed using the question: What is your postal address where you live as student? Once the participants self-reported their postal address, the research team geocoded both home and university in Google Maps, selecting the shortest network distance on foot in kilometres (km).

The commuting speed was calculated according to the equation: commuting distance (in km) divided by commuting time (in hours, the minutes of commuting time were previously converted into hours), and the result was expressed in km/hour.

Both commuting EE expressed in METs were calculated to estimate the energy cost of each mode of commuting, based in the code of Compendium of Physical Activities for Adults (CPAA) (Ainsworth et al., 2011). The specific METs score assigned (per minute) by each mode of commuting according to the code in the CPAA was multiplied by the commuting time to obtain the total EE estimated. The two commuting EE (per minute and total) were calculated to differentiate the modes of commuting since it is possible that total commuting EE from two different participants may be similar, but these expenditures might come from different behaviours (e.g., walking vs. sitting in public transport), and consequently, commuting EE per minute might be different. For greater precision, the commuting EE per minute of active commuting was established with their respective commuting speed calculated according to the ranges of the CPAA. For public and private transport, the commuting EE per minute was not assigned according to the commuting speed calculated since these speeds correspond to motorised transport. For public and private transport, the METs used were 1.3 METs (code 16016, riding in bus or train and code 16015, riding in car, respectively). Additionally, for public transport, previous research has determined that the median walking time included in this type of commuting is 15 minutes per day (Rissel et al., 2012). Therefore, 7.5 min per trip (to and from university) with an EE of 2.5 METs (code 17161), as considered in the CPAA for walking to the stations and stops, was used (see calculation examples in **Annexes IV**).

Sociodemographic Characteristics

Participants reported their day of birth to obtain their age, their gender (men or women), degree course, year of admission to the university, type of university (public or private), postal address (as university student), country, distance to university (response options were: <2 km, 2–5 km, and >5 km), type of residence (family residence: parents' home or own house, or university residence: shared flat with other students or hall of residence), locality area (urban or rural), and SES. For SES the Family Affluence Scale (FAS) was used (Boyce et al., 2006). The variables of family housing conditions are defined with the following questions: Does your family own a car? (No (0); Yes, one (1); Yes, two or more (2)); How many computers does your family own? (None (0); One (1); Two (2); More than two (3)); Do you have your own bedroom for yourself? (No (0); Yes (1)); and do you have internet access? (No (0); Yes (1)). A score was assigned to each answer and then summed in order to obtain the total points (from 0 to 7 points). Therefore, participants were classified into three categories regarding the SES: low (0 to 3 points), medium (4 to 5 points), and high (6 to 7 points).

PA and Sitting Time

The PA and sitting time were assessed using two methodologies: self-report and device-based, which will be explained below.

Self-reported measures

PA and sitting time were evaluated using the seven questions of the International PA Questionnaire short form (IPAQ-SF) (Craig et al., 2003). This questionnaire includes six questions related to the duration (in minutes) and frequency (days) of vigorous-intensity activities, moderate-intensity activities, and walking. In addition, includes one question related to the duration (minutes) of sitting time. Both moderate PA (moderate-intensity activity and walking), and vigorous PA were expressed in minutes/week. Finally, for participants, sitting time was considered question-related sitting, expressed in minutes/day. Participants had two different groupings depending on the study. The first classification was calculated and categorized using the METs and had three categories: light PA level corresponded to 3.3 METs x minutes x days per week; moderate PA level corresponded to 4 METs x moderate minutes x days per week; and vigorous PA level corresponded to 8 METs x minutes x days per week. Based on this, MVPA was calculated, as the sum of moderate PA and vigorous PA, and was considered as a continuous variable. The second classification was calculated based on the MVPA recommendations (≥150 min/week of MVPA) and has two categories: meeting MVPA recommendations and not meeting MVPA recommendations. The IPAQ-SF showed adequate reliability for Chilean university students (Palma-Leal et al., 2022), as well as in Spanish students, after being analysed with a test-retest design).

Device-measures

The ACTi Graph accelerometer GT3X+ (ACTi Graph, Pensacola, FL, USA) was used to measure PA levels and sitting time. Data were collected with the low-frequency extension filter disabled at a sampling frequency of 60 Hz and subsequently collapsed to 60 s epochs. Data from ACTi Graph accelerometers were downloaded and processed using the ACTi Life software v6.13.3. Non-wear periods were identified by applying the algorithm developed by Choi et al., (2012) (e.g., bouts of 90 continuous min (30 min minimum up/down stream time for consecutive zero counts, and a 2 min skip tolerance) with no data (counts) were considered non-wear time and excluded from the analyses). From the full-day data, only recordings during the commuting to and from university were studied, based on the completed diary. Participants were instructed to wear the accelerometer around their hips attached by an elastic belt over the whole day (24 h), for 8 days and were advised to keep on with their usual lifestyle. To protect the accelerometers, participants were asked to take them off while bathing or swimming. After these instructions, the participants were asked to commit to comply and to take care of the device. Accelerometer-wearing time was obtained by subtracting sleeping time (which was obtained from a diary in which participants indicated sleep and wake-up times) and non-wear periods from each day. PA levels and sitting time during the time of commuting to and from university were set as the time (min/journey) engaged in sedentary, light, moderate, vigorous, and

MVPA based upon standardised cut-offs of 0–200, 200–2689, 2690–6166, and ≥6167 counts per min, respectively (Aguilar-Farías et al., 2014).

Barriers to Active Commuting

The perceived barriers to active commuting were assessed using the Barriers to Active Commuting to University Scale. The Scale included 14 items referring to the barriers to active commuting to university, in relation to environment/safety, and planning/psychosocial barriers. The structure of answers on the four-point Likert-scale were: strongly disagree (1); disagree (2); agree (3); and strongly agree (4). In addition, the answers were grouped into disagreeing (disagree/strongly disagree) and agree (agree/strongly agree). These items were validated and reliable in Spanish university population (Molina-García et al., 2010), and showed appropriate reliability in Chilean university students (Palma-Leal et al., 2021).

Sleep Duration

Sleep duration was reported by participants according to the following sentence: Average hours of sleep per night (Monday-Friday), and the answer was the exact time on a 24-hour format of the sleep duration on weekdays. The question was reliable in university students (after being analysed with a test-retest design).

Breakfast Status

Breakfast status was assessed by answering the following question: Do you usually eat breakfast? The answer options were yes or no and were categorised as daily breakfast if they reported usually eating breakfast and skipping breakfast when participants reported not usually eating breakfast. The question was reliable for university students (after being analysed with a test-retest design).

Physical Fitness

The perceived physical fitness were assessed using the International Fitness Scale (IFIS) based on the answers to six basic questions about physical fitness: general physical condition, cardiorespiratory fitness, muscular strength, speed and agility, flexibility and general health (Ortega et al., 2011). The structure of answers on the five-point Likert-scale were: very poor (1), poor (2), average (3), good (4) and very good (5). The responses were used in two methods. First, the mean of each physical fitness component was used. Second, responses have been interpreted qualitatively using a normative quintile-based framework to classify the physical fitness levels (where those below the 20th centile are classified as 'very poor'; 20–40th centiles as 'poor'; 40–60th centiles as 'average'; 60–80th centiles as 'good' and those above the 80th centile as 'very good') as reported in previous studies (Catley & Tomkinson, 2013; Tomkinson et al., 2018). For further analyses, each of the physical fitness components was divided into high physical fitness or not high physical fitness (including in high physical fitness 'good' and 'very good' options). The IFIS questions showed reliability with an almost perfect degree of agreement in Chilean (Palma-Leal et al., 2022) as well as in Spanish university students (after being analysed with a test-retest design).

Body composition

Weight was measured with an electronic scale (SECA 861 Hamburg, Germany; range, 0.05–130 kg; precision, 0.05 kg) and height (measured in the Frankfort plane) with a telescopic stature-measuring instrument (Type SECA 225; range, 60–200 cm; precision, 1 mm). Body mass index (BMI) was calculated as weight/height squared (kg/m^2). Measurements were performed twice, and the mean value of the two measurements was used in the analyses.

Built environment features of university campuses

Six university campuses, three from each country, were considered for the assessment of the built environment. The evaluation of isolated faculties was excluded, under the criterion of complying the aims of evaluating the built environment features of university campuses.

All university campuses are located in coastal urban areas, with an average annual temperature of 15.5° in Chile and 18.2° in Spain (Celsius) according to the areas studied. The university campuses considered for Chile were: two from PUCV: campus PUCV Curauma, campus PUCV Sausalito, and one from Universidad Técnica Federico Santa María (UTFSM): campus UTFSM Casa Central, located in the Region of Valparaíso, central Chile. The university campuses considered for Spain were three campuses from the UCA: campus UCA Puerto Real, campus UCA Algeciras, and campus UCA Jerez. **Table 1** provides more information on the campuses and the context of their area, by country.

Table 1. Descriptive features of the university campuses evaluated in this study.

	University campuses					
	Chile			Spain		
	PUCV Curauma	UTFSM Casa Central	PUCV Sausalito	UCA Puerto Real	UCA Algeciras	UCA Jerez
Campus studied*						
Continent	Latin America	Latin America	Latin America	Europe	Europe	Europe
Geographical area	Region of Valparaíso	Region of Valparaíso	Region of Valparaíso	Province of Cádiz	Province of Cádiz	Province of Cádiz
Locality	Urban	Urban	Urban	Urban	Urban	Urban
Zone	Coastal	Coastal	Coastal	Coastal	Coastal	Coastal
Environment area (Ha)	7097.3	5626.6	8471.1	5044.1	8510.3	10857.5
Educational programs	Sciences, Journalism, and Kinesiology	Sciences, Engineering, and Architecture	Psychology, Philosophy, and Pedagogies	Engineering, and Pedagogies	Engineering, Human Resources, and Law	Social Sciences, Business, and Nursing

Notes: (Ha) hectare; (*) The data are from the websites of each university involved; (km^2) square kilometers; (PUCV) Pontificia Universidad Católica de Valparaíso; (UTFSM); Universidad Técnica Federico Santa María; (UCA) Universidad de Cádiz.

The assessment of the built environment of the university campuses was based on the 2500 meters radius of the catchment area size. This radius was selected as a threshold distance at which university students are willing to active commute (Chillon et al., 2016), and which has been used in a similar study in a university population (Horacek et al., 2018). Being the first study in these countries, this radius has been considered optimal to get a first overview of the immediate surroundings of the university, and due to the fact that a high use of walking versus cycling (which would require a larger radius) was identified in the study population.

In the literature, Geographic Information Systems (GIS) have been used to facilitate the collection, analysis and reporting of existing spatial data (Wieczorek & Delmerico, 2009). Therefore, the QGIS 3.22.14. software was used to evaluate the different built environment features of university campuses. Eight different built environment features were evaluated: residential density, connectivity, land-use mix, cycle lanes, bicycle racks, service density, green space density, and public space ratio. The unit, criteria, and methodology for each of the variables assessed in this study are presented in **Table 2.**

Table 2. Criteria and methodology used for the built environment features of university campuses of Chile and Spain.

Variables (unit)	Criteria	Methods (source)	Methods (calculation)
Residential density (inhab/Ha^2)	Ratio between the number of residents and the built environment area	Cadastral data from ATOM Inspire, Census sections and population from National Statistics Institute	Means of data disaggregation and aggregation operations, considering the number of dwellings
Connectivity (intersection/km^2)	Ratio between the number of street intersections and built environment area	Census and CDAU tract layers	Extracting vertices at the end of street segment, and counting points by buffering, eliminating duplicate vertices
Land-use mix (0-1) units	Uniformity in the distribution of surfaces of land uses (residential, leisure, commercial, industrial, and public services) in each area	According to the number of activities by categories (to Chile), and the procedure included in the IPEN project(Frank et al., 2005) (to Spain)	The building layer of the ATOM Inspire cadastral database and a massive query of unprotected cadastral data from the cadastre website are used to calculate the surface areas of the uses (to Chile in the formula the surface areas have been substituted by the number of activities by category), both forms are proportional
Cycle lanes (ml)	Linear metres of cycle lanes in the built environment area	Data was obtained from OSM (for both cycling services: lanes and racks)	Total sum in the area (for both cycling services: lanes and rack)
Bicycle racks (n)	Number of bicycle racks in the built environment area		
Service density (n/Ha)	Ratio between the number of services (transport stops, commerce, restaurants, etc.) and the built environment area	Data was obtained by OSM using BBBike and Geofabrik	To count the areas, they are converted to centroids
Green Space Density (m^2/m^2)	Ratio between the green space area and the built environment area	Data was obtained from DERA, LINE@ and OSM by combining data	Overlapping areas were eliminated. Surrounding areas were counted and summed.
Public space ratio (m^2/m^2)	Ratio between the building area and the environment area	Data obtained from the elaboration of a 3D digital model of the urban surface including buildings	The resulting coefficient corresponds to the amount of public space. The closer it is to the unit, the less public space there is, i.e., less visibility

Notes: (inhab) inhabitants; (Ha) hectare; (km^2) square kilometres; (m^2) square meters; (ml) linear meters; (n) number; (CDAU) Unified Digital Street Map of Andalusia; (IPEN) International Physical Activity and Environment Network; (OSM) Open Street Map; (DERA) Spatial Reference Data of Andalusia; (LINE@) Spatial Information Locator of Andalusia.

Section I: Commuting patterns, sociodemographic characteristics, PA, and physical fitness of university students in Chile

In the two cross-sectional studies included in this Section, the participants were recruited from three different public and private universities (public: PUCV and UTFSM; and private: Universidad de las Américas (UDLA)) located in urban cities in the central zone of Chile (two in Valparaíso and one in Santiago). The students belonged to diverse faculties and campuses.

Study I: New self-report measures of commuting variables to university and their association with sociodemographic characteristics

Sample

A total of 1257 university students (52.4% women), with an average age of 22.4 ± 5.6 years participated in this study.

Study variables

Commuting Patterns: In this study the mode of commuting showed the responses separately, and, in addition, the first classification with three categories (i.e., active commuting, private transport, and public transport) was used. Additionally, the five commuting variables (i.e., commuting time, commuting distance, commuting speed, commuting EE per minute, and total commuting EE) were considered.

Sociodemographic Characteristics: The sociodemographic characteristics considered in this study were age, gender, degree, type of university, postal address, distance to university, type of residence, locality area, and SES.

Statistical Analysis

Mode of commuting and sociodemographic characteristics were analysed using descriptive statistics and were reported as the mean ± standard deviation (SD) for continuous variables and as frequencies and percentages (%) for categorical variables. The significant differences in these descriptive variables for men and women were analysed using chi-square test for categorical variables and standard analysis of variance (ANOVA) for continuous variables, where the level of significance was set to $p < 0.05$. Associations between mode of commuting with sociodemographic characteristics were studied using multinomial logistic regression analysis. Mode of commuting were included in the model as the dependent variable, where private transport was established as reference, and sociodemographic characteristics were included as independent variables individually and adjusted by distance, age, and SES (except in the analysis when that variable was the predictor). Associations between commuting variables (speed and EE) and sociodemographic characteristics were studied using linear regression. Commuting variables were included in the model as the dependent variable, and sociodemographic characteristics were included as independent variables individually and adjusted by distance, age, and SES (except in the analysis when that variable was the predictor). The statistical analyses were conducted using the IBM SPSS Statistics (v. 25.0 for Windows, Chicago, IL, USA), and all analyses were performed jointly for men and women and adjusted by gender.

Study II: Active commuting to university is positively associated with PA and physical fitness

Sample

A total of 1257 university students (52.4% women), with an average age of 22.4 ± 5.6 years participated in this study.

Study variables

Commuting Patterns: The first classification of mode of commuting with three categories (i.e., active commuting, private transport, and public transport) was used in this study.

Sociodemographic Characteristics: The sociodemographic characteristics considered in this study was the gender.

PA and Sitting Time: The first (i.e., light PA, moderate PA, and vigorous PA) and second classification of PA (i.e., meeting MVPA recommendations or not) as well as information on sitting time were considered, using self-reported measures.

Physical Fitness: The mean of each physical fitness component was used (i.e., general physical condition, cardiorespiratory fitness, muscular strength, speed and agility, flexibility, and general health).

Statistical Analysis

Descriptive statistics were reported for participants' mode of commuting, PA and physical fitness, separated by gender. Means and SD were reported for continuous variables, and frequencies and % were reported for categorical variables. The significant differences were analysed using chi-square test for categorical variables and ANOVA for continuous variables, where the level of significance was set to $p < 0.05$. Associations between mode of commuting and PA, as well as physical fitness, were studied using multinomial logistic regression analysis. Mode of commuting was included in the model as the dependent variable, where private transport was established as a reference, and PA and physical fitness were included as independent variables in separate models. A complementary analysis was repeated conducting the same multinomial logistic regression but adjusting for physical fitness and PA in order to take into account the potential interaction. In addition, another complementary analysis was carried out to identify the associations between PA recommendations and physical fitness by gender. PA recommendations were included in the model as the dependent variable, where not meeting MVPA recommendations was established as a reference, and physical fitness was included as an independent variable. All logistic regression analyses were separated by gender. An additional analysis was conducted to examine the effect of both mode of commuting and PA on physical fitness. For this analysis, six categorical groups based on the three modes of commuting (active, public and private) and the PA (meeting or not meeting MVPA recommendations) were calculated (e.g., active–meeting MVPA, public–meeting MVPA, private–meeting MVPA, active–not meeting MVPA, public–not meeting MVPA and private–meeting MVPA). The six physical fitness components were included as independent variables in a one-way ANOVA, and a post hoc subcommand Bonferroni test was used to compare the means of the categorical groups created between the three modes of commuting and PA (meeting or not meeting MVPA recommendations). The statistical analyses were conducted using IBM SPSS Statistics (v. 25.0 for Windows, Chicago, IL, USA).

Section II: Commuting patterns, sociodemographic characteristics, PA, and physical fitness of university students in Spain

In the two cross-sectional studies included in this Section, the participants were recruited from the public UCA, located in urban cities in southern Spain. The students belonged to diverse faculties and campuses.

Study III: Associations between active commuting and sociodemographic characteristics, PA level and physical fitness in Spanish university students

Sample

A total of 1012 university students (53.6% women), with an average age of 27.3 ± 6.0 years participated in this study.

Study variables

Commuting Patterns: In this study the mode of commuting showed the responses separately, and, in addition, the first classification of mode of commuting with three categories (i.e., active commuting, private transport, and public transport) was used in this study.

Sociodemographic Characteristics: The sociodemographic characteristics considered in this study were age, gender, distance to university, type of residence, and SES.

PA: The first (i.e., light PA, moderate PA, and vigorous PA) and second classification of PA (i.e., meeting MVPA recommendations or not) were considered, using self-reported measures.

Physical Fitness: The mean of each physical fitness component was used.

Statistical Analysis

Means and SD were reported for continuous variables, and frequencies and % for categorical variables. The significant differences in these descriptive variables for men and women were analysed using ANOVA for continuous variables and the chi-square test for categorical variables. Associations between mode of commuting with sociodemographic characteristics, as well as PA and physical fitness, were studied using multinomial logistic regression analysis. Mode of commuting was included in the model as the dependent variable, where private transport was established as reference, and sociodemographic characteristics, PA, and physical fitness were included as independent variables individually in separate models and adjusted by SES and distance to university (except in the analysis when the variable was calculated). We conducted these analyses separately by gender. A complementary analysis was replicated, to identify the different between public transport vs. active commuting. The level of significance in all analyses was set to $p<0.05$. The statistical analyses were conducted using the IBM SPSS Statistics (v. 25.0 for Windows, Chicago, IL, USA).

Study IV: Commuting to university: self-reported and device-measured PA and sitting time

Sample

From the original total of 1012 participants, 99 university students used a measured device, which was the aim of this study. Participants who did not provide complete data (n = 30), and those who did not meet the accelerometery inclusion criteria (n = 6) were excluded. Therefore, a total of 63 university students (65.1% women), with an average age of 20.6 ± 3.8 years participated in this study.

Study variables

Commuting Patterns: The first classification of mode of commuting with three categories (i.e., active commuting, private transport, and public transport) was used in this study. Additionally, the five commuting variables were considered.

Sociodemographic Characteristics: The sociodemographic characteristics considered in this study were age, gender, postal address, type of residence, and SES.

PA and Sitting Time: The first (i.e., light PA, moderate PA, and vigorous PA) and second classification of PA (i.e., meeting MVPA recommendations or not), as well as information on sitting time were considered, using device -measures.

Boby composition: Height, weight and BMI were used.

Statistical Analysis

Descriptive characteristics were analysed using descriptive statistics and were reported as the mean ± SD for continuous variables and as frequencies and % for categorical variables. The differences in the descriptive characteristics between each mode of commuting were analysed using chi-square test and ANOVA for categorical and continuous variables, respectively. Post hoc analysis with Bonferroni's correction was used due to the large number of comparisons between the groups and to ascertain differences between them (active vs. public transport, active vs. private transport, and public vs. private transport). Self-reported and device measured of commuting variables, PA, and sitting time in both trips (to and from university) by mode of commuting, were presented as medians and interquartile ranges (IQRs (Q3–Q1)). The differences in self-reported and device-measured of commuting variables, PA, and sitting time were analysed using the Kruskal–Wallis test. Additionally, to ascertain differences between groups the Mann–Whitney test was used. Finally, associations between self-reported and device-measured of commuting variables, PA, and sitting time were studied using linear regression. Self-reported measures to and from university were included in the model as dependent variables, and the device measured data were included as independent variables individually in separate models for each mode of commuting. To ascertain whether "to" and "from" university differed, a paired t-test was carried out, which turned out to be significant, therefore the results were shown separately. The level of significance in all analyses was set to $p < 0.05$. The statistical analyses were conducted using the IBM SPSS Statistics (v.25.0 for Windows, Chicago, IL, USA).

Section III: University lifestyle, barriers to active commuting and built environment in the university context of Chile and Spain

In the three cross-sectional studies included in this Section, was considered the data that were collected in Chile and Spain.

Study V: What lifestyle behaviours are associated with physical fitness in university students?

Sample

A total of 2269 university students (52.9% women), with an average age of 26.8 ± 6.0 years old, participated in the present study.

Study variables

Commuting Patterns: The second classification of mode of commuting with two categories (i.e., active commuting and motorised transport) was used in this study.

Sociodemographic Characteristics: The sociodemographic characteristics considered in this study were age, gender, and country.

PA and Sitting Time: The second classification of PA (i.e., meeting MVPA recommendations or not) as well as information on sitting time, were considered, using self-reported measures.

Sleep Duration: The average hours of sleep per night (Monday-Friday) was considered.

Breakfast Status: The classification of breakfast status was used.

Physical Fitness: The second classification was used (high or not high). Two components of physical fitness were considered: cardiorespiratory fitness and muscular strength.

Statistical Analysis

Descriptive statistics were reported as the mean ± SD for continuous variables and as frequencies and % for categorical variables. To establish different lifestyle behaviour patterns, a two-step cluster analysis was performed. All continuous variables were converted into standardised scores (z scores) to ensure a uniform scale. Silhouette measures of cohesion and separation were used to determine the cluster quality. In addition, to ascertain whether there were differences by country of residence, a multilevel analysis was carried out, which was not statistically significant, and the results were shown to be maintained. Associations between the different lifestyle behaviour patterns established (independent variables) among the highest reported physical fitness components (dependent variables) were tested by binary logistic regression models. All the analyses were adjusted by age, gender, and country of residence. The statistical analyses were conducted using IBM SPSS Statistics (v. 25.0 for Windows, Chicago, IL, USA).

Study VI: Environmental and psychosocial barriers to active commuting to university in Chilean and Spanish students: which one matters more?

Sample

A total of 2269 university students (52.9% women), with an average age of 26.8 ± 6.0 years old, participated in the present study.

Study variables

Commuting Patterns: The first classification of mode of commuting with three categories (i.e., active commuting, private transport, and public transport) was used in this study.

Sociodemographic Characteristics: The sociodemographic characteristics considered in this study were gender, country, and distance to university.

Barriers to active commuting: The 14 items of the Barriers to Active Commuting to University Scale were considered in this study.

Statistical Analysis

Descriptive characteristics (e.g., locality area, type of residence and distance to university), mode of commuting (e.g., active, public, and private) and perceived barriers to active commuting were reported as frequencies and %. The differences in the modes of commuting and the perceived barriers to active commuting among gender (e.g., men vs women) and country (e.g., Chilean vs Spanish), were analysed using the chi-square test. Additionally, a Post-hoc analysis with Bonferroni's correction was used to ascertain differences between groups (e.g., Chilean men vs. Chilean women, Spanish men vs. Spanish women, Chilean men vs. Spanish men, and Chilean women vs. Spanish women). Finally, associations between the mode of commuting and the perceived barriers to active commute to university were studied using multinominal logistic regression analysis adjusted by distance to the university. Mode of commuting was included in the model as the dependent variable, where active commuting was established as a reference, and the perceived barriers to active commuting to university were included as independent variables in separate models, where disagreement was established as a reference. All multinominal logistics regression analyses were adjusted for the distance to the university and separated by gender and country. The level of significance in all analyses was set to $p < 0.05$. The statistical analyses were conducted using the IBM SPSS Statistics (v. 25.0 for Windows, Chicago, IL, USA.).

Study VII: How is the built environment around university campuses associated with travel behaviours of Chilean and Spanish students?

Sample

From the original total of 2269 participants, students who attended isolated faculties were excluded. Therefore, a total of 1419 university students (47.3% women), with an average age of 25.6 ± 4.7 years were included in the present study.

Study variables

Commuting Patterns: The second classification of mode of commuting with two categories (i.e., active commuting and motorised transport) was used in this study. In addition, the commuting distance was considered.

Sociodemographic Characteristics: The sociodemographic characteristics considered in this study were SES, degree course and country.

Built environment features of university campuses: The eight different built environment features were considered in the six university campuses evaluated (i.e., residential density, connectivity, land-use mix, cycle lanes, bicycle racks, service density, green space density, and public space ratio).

Spatial and statistical analysis

The spatial analysis was carried out by mapping the quantitative data obtained from the variables studied (the raw values of the built environment features), according to the buffer assigned for each university campus using the QGIS 3.22.14. software. After the mapping, each of the raw values of the eight built environment features were set to z-scores. Subsequently, we combined the individual z-scores of the eight built environment features to formulate a composite score of the built environment features for each university campus (higher score = higher activity-friendly). Descriptive statistics of travel behaviours were analysed and reported as frequencies and percentages (%), and the SES and commuting distance as mean ± SD. The differences in the travel behaviours between campuses were analysed using chi-square test, and for the SES and commuting distance ANOVA was used. Prior to the associations, a preliminary moderator analysis was carried out to confirm whether separate analyses should be carried out for each country. As a result, we found that "country" was a significant moderator of the effects of the composite score of the built environment features in travel behaviours ($p<0.05$). Therefore, we conducted analyses separately for Chile and Spain. Finally, associations between the composite score of the built environment features of each university campus and travel behaviour were studied using binary logistic regression analysis. Travel behaviour was included in the model as the dependent variable (where motorised transport was established as a reference), and the university campus (the composite score of the built environment features of each one) was included as categorical independent variable (where the lowest composite score was set as the reference, by country). Additionally, this analysis was repeated in three models adjusting by SES, commuting distance and combining both. The significance level was set to $p < 0.05$. The analyses were conducted using IBM SPSS Statistics (v. 25.0 for Windows, Chicago, IL, USA).

Summary overview of the methodology are presented in **Figure 2**.

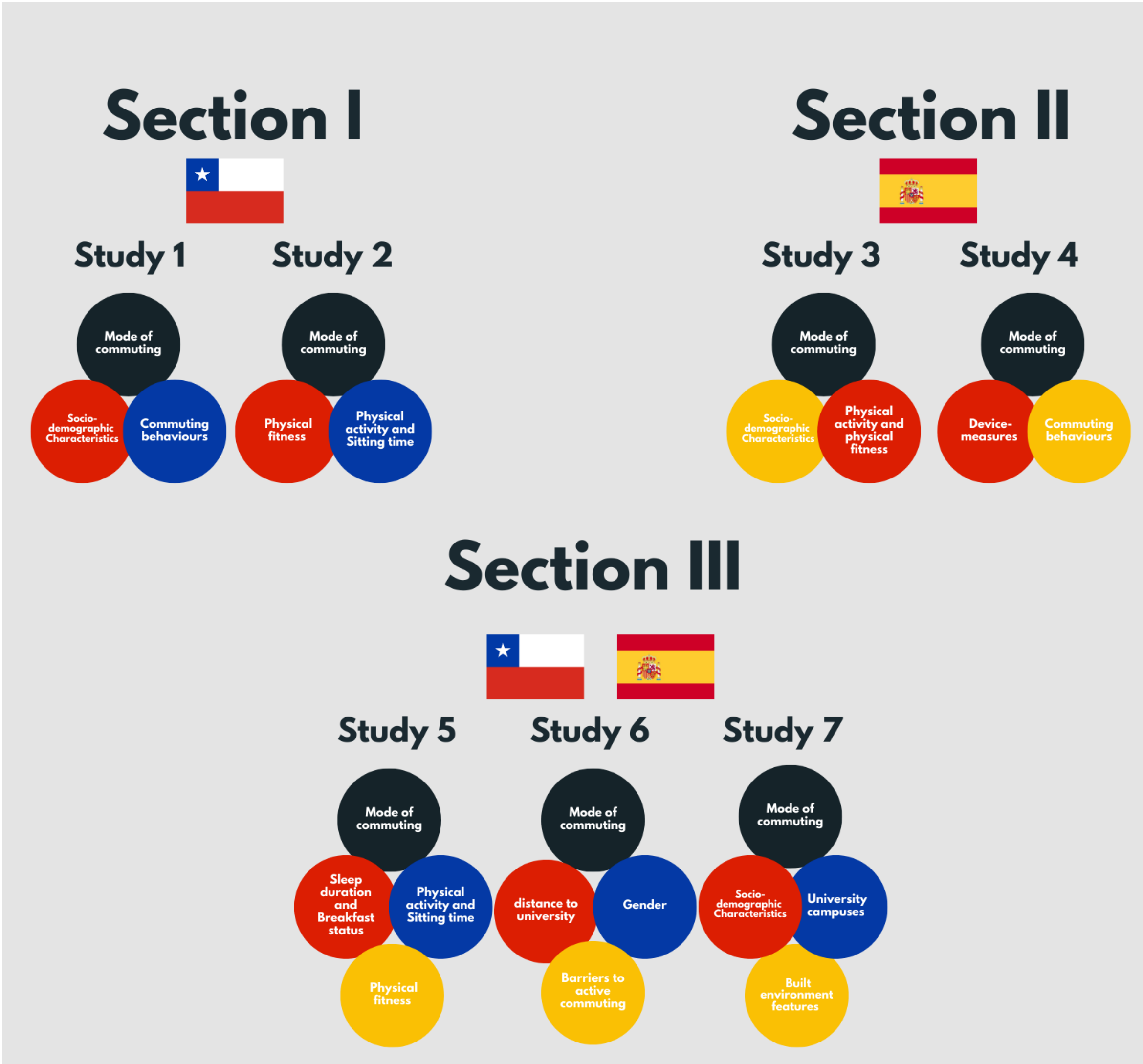

Figure 2. Summary overview of the methodology of the seven cross-sectional studies included in this International Doctoral Thesis by Sections.

Notes: different specific sociodemographic characteristics were used in the studies that have not been stated in the Figure.

RESULTS

Section I

Study 1 and Study 2: Patterns

Commuting patterns to and from university in Chilean students by gender are shown in **Figure 3**. The main mode of commuting to and from university was public bus, higher in women than men (p<0.001), followed by walking, with higher percentages in men than in women (p<0.001). Regarding going to university by motorcycle, there was significant differences between women and men (p<0.05). In addition, two statistical differences in the mode of commuting from university by car and cycling were found, with men showing lower percentages in car (p<0.05) and higher percentages in cycling (p<0.05) than women.

The mode of commuting categorized, the sociodemographic characteristics, and commuting variables by gender are presented in **Table 3**. Men were significantly older than women and more men lived in family residence than women (both, p<0.001). Most of the sample lived in urban areas (96.8%) and had a medium SES (52.6%), without statistical differences among gender. A 71.4% of men and 44.9% of women came from public universities (p<0.001). The commuting time and commuting distance to university were higher in public than private transport (p<0.001). The commuting speed was higher in private transport followed by public transport and active commuting (p<0.001). The commuting EE per min was higher in active commuters followed by public and private transport users, and total commuting EE was higher in public transport users, followed by active commuters and private transport users in women and men (all, p<0.001).

The PA, sitting time, and physical fitness of the participants by gender are displayed in **Table 4**. Regarding PA levels, most men showed a vigorous PA level (43.3%), while most women showed a light PA level (49.6%) (p<0.001). In addition, 54.5% of men, and 41.4% of women reported meeting the MVPA recommendations (p<0.001). The mean total PA time was 1.9 ± 1.8 hr/day in men and 1.2 ± 1.4 hr/day in women (p<0.001). In contrast, the mean sitting time was 6.8 ± 6.9 hr/day in men and 6.2 ± 5.9 in women (p<0.001). Additionally, there were significant differences among all physical fitness components (p<0.001), where women presented lower mean scores, except in flexibility.

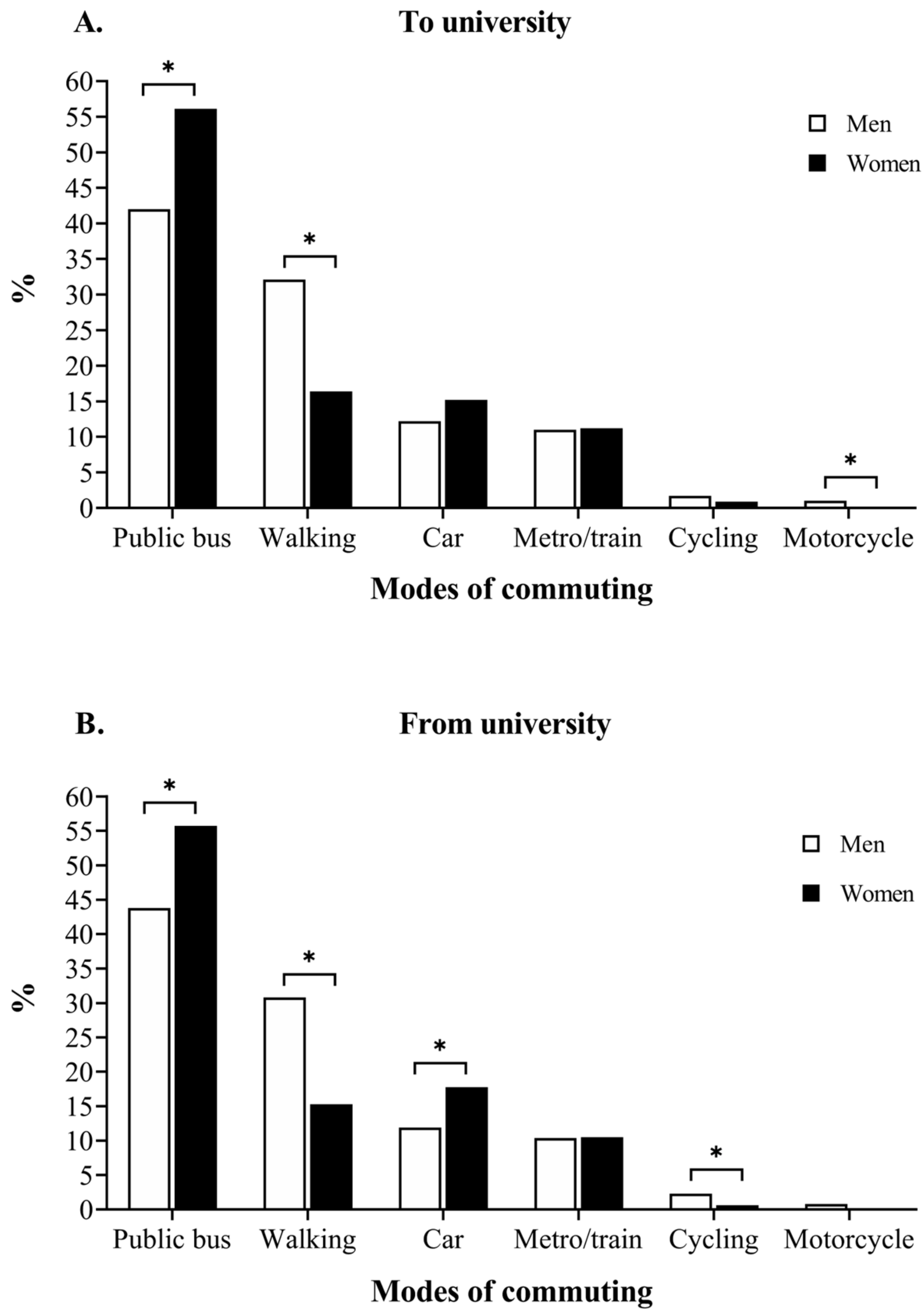

Figure 3. Commuting patterns A) to university and B) from university in university students by gender.

Notes: (*) Significant differences with $p<0.05$.

Table 3. Mode of commuting, sociodemographic characteristics, and commuting variables of participants by gender.

	All (n= 1257)	Men (n= 598)	Women (n= 659)	*p*-value
Classified mode of commuting				
Active commuting	331 (26.3)	206 (34.4)	125 (19.0)	<0.001
Public transport	791 (62.9)	332 (55.5)	459 (69.7)	
Private transport	135 (10.7)	60 (10.0)	75 (11.4)	
Sociodemographic characteristics				
Age (years)	22.4 ± 5.6	25.0 ± 7.2	20.2 ± 1.9	<0.001
Younger (18-25)	1021 (81.2)	384 (64.2)	637 (96.7)	<0.001
Older (>26)	236 (18.8)	214 (35.8)	22 (3.3)	
Type of residence				
Family residence	894 (71.1)	367 (61.4)	527 (20.0)	<0.001
University residence	363 (28.9)	231 (38.6)	132 (80.0)	
Locality area				
Rural	40 (3.2)	15 (2.5)	25 (3.8)	0.195
Urban	1217 (96.8)	583 (97.5)	634 (96.2)	
Socioeconomic status				
High	213 (16.9)	92 (15.4)	121 (18.4)	
Medium	661 (52.6)	318 (53.2)	343 (52.0)	0.356
Low	383 (30.5)	188 (31.4)	195 (29.6)	
Type of university				
Private	534 (42.5)	171 (28.6)	363 (55.1)	<0.001
Public	723 (57.5)	427 (71.4)	296 (44.9)	
Commuting variables				
Commuting time (min)				
Private transport	17.6 ± 22.0	18.5 ± 22.2	17.0 ± 21.8	<0.001
Public transport	24.2 ± 27.6	21.4 ± 27.2	26.7 ± 27.2	<0.001
Active commuting	24.4 ± 17.9	25.0 ± 17.6	23.7 ± 18.2	<0.001
Commuting distance (km)				
Private transport	12.5 ± 16.7	11.0 ± 9.9	13.7 ± 20.6	<0.001
Public transport	14.4 ± 12.9	14.0 ± 13.2	14.7 ± 12.7	<0.001
Active commuting	1.8 ± 3.3	1.8 ± 3.7	1.9 ± 3.7	<0.001
Commuting speed (km/hr)				
Private transport	79.1 ± 125.5	57.7 ± 70.8	92.3 ± 148.3	<0.001
Public transport	28.4 ± 28.2	26.6 ± 23.7	29.7 ± 31.0	<0.001
Active commuting	4.5 ± 8.5	3.2 ± 6.3	6.2 ± 10.4	<0.001
Energy expenditure per min (METs)				
Private transport	1.3 ± 0.0	1.3 ± 0.0	1.3 ± 0.0	0.985
Public transport	1.8 ± 0.4	1.8 ± 0.4	1.8 ± 0.5	0.122
Active commuting	5.9 ± 2.4	5.8 ± 2.3	6.0 ± 2.6	0.096
Total energy expenditure (METs)				
Private transport	70.9 ± 69.2	74.4 ± 77.7	67.4 ± 61.8	<0.001
Public transport	154.9 ± 66.4	149.9 ± 63.8	158.5 ± 67.4	<0.001
Active commuting	120.5 ± 93.2	113.8 ± 99.6	131.7 ± 91.5	<0.001

Notes: Data are expressed as mean ± standard deviation for continuous variables and as frequencies and percentages for categorical variables; (min) minutes; (km) kilometres; (km/hr) kilometres/hours, and (METs) Metabolic Equivalents.

Table 4. Descriptive data of the physical activity, sitting time, and physical fitness of the participants, and significant differences in the gender.

	All (n = 1257)	Men (n = 598)	Women (n = 659)	*p*-value
PA and Sitting time				
PA Levels				
Light	482 (38.3)	155 (25.9)	327 (49.6)	
Moderate	365 (29.0)	184 (30.8)	181 (27.5)	<0.001
Vigorous	410 (32.6)	259 (43.3)	151 (22.9)	
MVPA recommendations				
Not meeting	701 (55.8)	272 (45.5)	429 (61.2)	<0.001
Meeting	556 (44.2)	326 (54.5)	230 (41.4)	
Total PA (hr/day)	1.5 ± 1.7	1.9 ± 1.8	1.2 ± 1.4	<0.001
Sitting time (hr/day)	6.5 ± 6.4	6.8 ± 6.9	6.2 ± 5.9	<0.001
Physical Fitness				
General Physical Condition	2.9 ± 1.0	3.2 ± 0.9	2.7 ± 0.9	<0.001
Cardio-respiratory Fitness	2.8 ± 1.0	3.1 ± 1.0	2.5 ± 1.0	<0.001
Muscular Strength	2.9 ± 0.9	3.2 ± 0.9	2.7 ± 0.9	<0.001
Speed and Agility	3.1 ± 0.9	3.4 ± 0.9	2.7 ± 0.9	<0.001
Flexibility	2.8 ± 1.0	2.8 ± 1.0	2.9 ± 1.0	<0.001
General Health	3.6 ± 0.9	3.8 ± 0.9	3.4 ± 0.8	<0.001

Notes: Data are expressed as mean ± standard deviation for continuous variables and as frequencies and percentages for categorical variables; (PA) Physical Activity.

Study 1 and Study 2: Correlates

The mode of commuting associated with sociodemographic characteristics by gender are shown in **Table 5**. The most active commuters were those older, who lived in university residence, and belonged to public universities (p<0.05). Women that belonged to low and medium SES also showed to be the most active commuters (p<0.05). Men who used public transport were older, belonged to low SES and to public universities; and women who use public transport were those who belonged to low and medium SES, and to public universities, compared to those who used private transport (p<0.05). According to the commuting variables, in men and women, active commuting decrease with higher commuting time and distance (both, p<0.05). Finally, active commuters and public transport users reported higher EE per min and total EE, compared to those that use private transport (both, p<0.05).

The commuting variables associated with sociodemographic characteristics by gender are presented in **Table 6**. The commuting speed presented negative associations with men and women students who lived in university residence (both, $p<0.05$). The commuting speed showed one negative association with men students who belong to public universities, and one positive association with women who belonged to urban locality area (both, $p<0.05$). Regarding commuting EE per min, men and women presented positive associations with living in university residence and belonging to public universities (both, $p<0.05$).

The associations of the mode of commuting with PA levels, sitting time, and physical fitness by gender are shown in **Table 7**. Active commuters had higher moderate (men: $p=0.021$) and vigorous PA levels (women: $p=0.022$) than those who used private transport. Active commuters met the MVPA recommendations (men: $p=0.042$; women: $p=0.028$) and had higher total PA (women: $p=0.036$), than those who used private transport. Active commuters and public transport user reported engaging in less sitting time ($p<0.001$ and $p=0.001$, respectively) than those who used a private transport. Regarding physical fitness, men who use active commuting and public transport showed higher muscular strength ($p=0.001$, $p=0.003$ respectively) compared to those who used private transport. Finally, public transport users reported higher flexibility and general health (women: $p=0.030$; men: $p=0.040$, respectively) compared to students who used private transport. The same analysis was repeated adjusting by MVPA recommendations and physical fitness and similar results were obtained (**Annexes V**).

The associations between the mode of commuting and meeting MVPA recommendations with physical fitness in men and women, are illustrated in **Figure 4** and **Figure 5**, respectively. men and women students who use active commuting, and public, and private transport, who met MVPA recommendations reported higher general physical condition compared with their peers who did not meet MVPA recommendations. Men active commuters and public transport users who met MVPA recommendations, reported higher cardio-respiratory fitness, muscular strength, speed and agility, and general health, compared to students who use active commuting and public transport and did not meet MVPA recommendations. Public transport users who met MVPA recommendations reported higher flexibility, compared to those that use public transport and did not meet MVPA recommendations. Women who use public, and private transport and met MVPA recommendations, reported higher cardio-respiratory fitness, and public transport user who met MVPA recommendations reported higher muscular strength, speed and agility, flexibility, and general health, compared to those that use public transport and did not meet MVPA recommendations.

Table 5. Associations between mode of commuting with sociodemographic characteristics and commuting variables measures by gender.

	Mode of commuting to university*			
	Men		Women	
	Active	Public	Active	Public
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Sociodemographic				
Age (years)				
Younger (18-25)	Ref.	Ref.	Ref.	Ref.
Older (>26)	**3.63 (1.63, 8.10)**	**2.24 (1.13, 4,44)**	**8.84 (3.94, 13.78)**	0.84 (0.21, 1.74)
Type of residence				
Family residence	Ref.	Ref.	Ref.	Ref.
University residence	**12.43 (4.39, 35.19)**	2.33 (0.86, 6.25)	**3.95 (1.31, 11.85)**	1.34 (0.50, 3.57)
Locality area				
Rural	Ref.	Ref.	Ref.	Ref.
Urban	1.57 (0.06, 36.43)	1.66 (0.20, 13.70)	1.47 (0.04, 44.94)	1.19 (0.32, 4.40)
Socioeconomic status				
High	Ref.	Ref.	Ref.	Ref.
Medium	0.81 (0.31, 2.14)	1.30 (0.62, 2.73)	**2.44 (1.02, 5.81)**	**2.75 (1.56, 4.83)**
Low	3.10 (0.95, 10.09)	**3.82 (1.43, 10.18)**	**4.93 (1.63, 14.90)**	**4.70 (2.19, 10.06)**
Type of university				
Private	Ref.	Ref.	Ref.	Ref.
Public	**26.75 (10.63, 67.34)**	**13.68 (6.34, 29.51)**	**8.02 (3.00, 21.48)**	**3.75 (1.74, 8.11)**
Commuting variables				
Commuting time	**0.93 (0.87, 0.99)**	1.00 (0.94, 1.06)	**0.92 (0.88, 0.96)**	0.99 (0.96, 1.02)
Commuting distance	**0.54 (0.31, 0.92)**	1.02 (0.99, 1.05)	**0.49 (0.42, 0.57)**	1.00 (0.98, 1.02)
Commuting speed	2.11 (0.16, 4.38)	0.94 (0.76, 1.15)	0.96 (0.91, 1.02)	0.97 (0.92, 1.02)
Energy expenditure per min	**16.68 (7.73, 19.69)**	**9.11 (6.85, 15.07)**	**19.04 (8.18, 25.68)**	**8.76 (4.11, 13.20)**
Energy expenditure	**1.01 (1.00, 1.02)**	**1.02 (1.01, 1.03)**	**1.02 (1.01, 1.03)**	**1.03 (1.02, 1.04)**

Notes: analysis were adjusted for distance, age, and socioeconomic status (except in the analysis when that variable was the predictor variable); (OR) Odd Ratio; (95% CI) 95% Confidence Intervals; (*) Private transport was stablished as reference; (bold) significant association with $p<0.05$.

Table 6. Associations between commuting variables with sociodemographic characteristics in university students by gender.

	Commuting variables to university			
	Men		Women	
	Speed	EE per min	Speed	EE per min
	Beta (95% CI)	*Beta* (95% CI)	*Beta* (95% CI)	*Beta* (95% CI)
Sociodemographic characteristics				
Age (years)				
Younger (18-25)	Ref.	Ref.	Ref.	Ref.
Older (>26)	-2.24 (-7.60, 3.11)	0.33 (-0.07, 0.73)	3.99 (-11.95, 19.94)	0.47 (-0.40, 1.35)
Type of residence				
Family residence	Ref.	Ref.	Ref.	Ref.
University residence	**-19.64 (-24.81, -14.47)**	**2.55 (2.19, 2.90)**	**-19.12 (-25.72, -12.52)**	**2.05 (1.68, 2.43)**
Locality area				
Rural	Ref.	Ref.	Ref.	Ref.
Urban	15.21 (-4.25, 34.68)	-1.22 (-2.50, 0.05)	**24.97 (6.06, 43.87)**	-0.93 (-1.76, -0.11)
Socioeconomic status				
High	Ref.	Ref.	Ref.	Ref.
Medium	1.46 (-2.56, 5.49)	0.07 (-0.22, 0.37)	4.27 (-0.99, 9.56)	-0.01 (-0.27, 0.19)
Low	-1.67 (-5.46, 2.16)	0.01 (-0.19, 0.22)	-4.18 (-8.77, 0.41)	0.76 (-0.19, 0.34)
Type of university				
Private	Ref.	Ref.	Ref.	Ref.
Public	**-10.03 (-17.13, -2.93)**	**1.34 (0.92, 1.77)**	-5.65 (-13.09, 1.88)	**0.97 (0.62, 1.33)**

Notes: analysis were adjusted for age and socioeconomic status (except in the analysis when that variable was the predictor variable); (Beta) Unstandardized Beta coefficient; (95% CI) 95% Confidence Intervals; (EE) Energy expenditure; (bold) significant association with $p<0.05$.

Table 7. Associations between mode of commuting with PA, sitting time, and physical fitness by gender.

	Mode of commuting to university*			
	Men		Women	
	Active	Public	Active	Public
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Physical Activity and Sitting time				
PA Levels				
Light	Ref.	Ref.	Ref.	Ref.
Moderate	**2.50 (1.14, 5.14)**	1.82 (0.86, 3.85)	1.31 (0.67, 2.54)	1.04 (0.59, 1.81)
Vigorous	1.47 (0.75, 2.90)	1.36 (0.72, 2.57)	**2.58 (1.14, 5.81)**	2.02 (0.98, 4.18)
MVPA recommendations				
Not meeting	Ref.	Ref.	Ref.	Ref.
Meeting	**1.35 (1.16, 2.04)**	1.22 (0.74, 2,24)	**2.03 (1.08, 3.81)**	1.57 (0.90, 2.74)
Total physical activity	0.89 (0.77, 1.04)	0.95 (0.83, 1.09)	**1.29 (1.01, 1.65)**	1.21 (0.97, 1.52)
Sitting time	0.85 (0.32, 1.07)	0.70 (0.39, 1.24)	**0.30 (0.16, 0.54)**	**0.42 (0.25, 0.69)**
Physical Fitness				
General physical condition	1.07 (0.80, 1.44)	1.21 (0.91, 1.61)	0.74 (0.55, 1.01)	0.81 (0.62, 1.05)
Cardio-respiratory fitness	1.15 (0.87, 1.52)	1.22 (0.94, 1.60)	0.78 (0.59, 1.03)	0.85 (0.67, 1.08)
Muscular strength	**1.69 (1.22, 2.33)**	**1.59 (1.17, 2.17)**	1.26 (0.94, 1.70)	1.21 (0.94, 1.56)
Speed and agility	1.20 (0.89, 1.62)	1.30 (0.98, 1.74)	1.07 (0.78, 1.46)	1.04 (0.80, 1.35)
Flexibility	1.13 (0.86, 1.49)	1.24 (0.96, 1.62)	1.25 (0.95, 1.65)	**1.29 (1.02, 1.63)**
General health	1.21 (0.87, 1.70)	**1.39 (1.01, 1.09)**	0.93 (0.67, 1.29)	1.17 (0.88, 1.54)

Notes: (OR) Odd Ratio; (95% CI) 95% Confidence Intervals; (Ref.) reference; (MVPA) moderate to vigorous physical activity; (*) Private transport was established as reference; (bold) significant association with $p<0.05$.

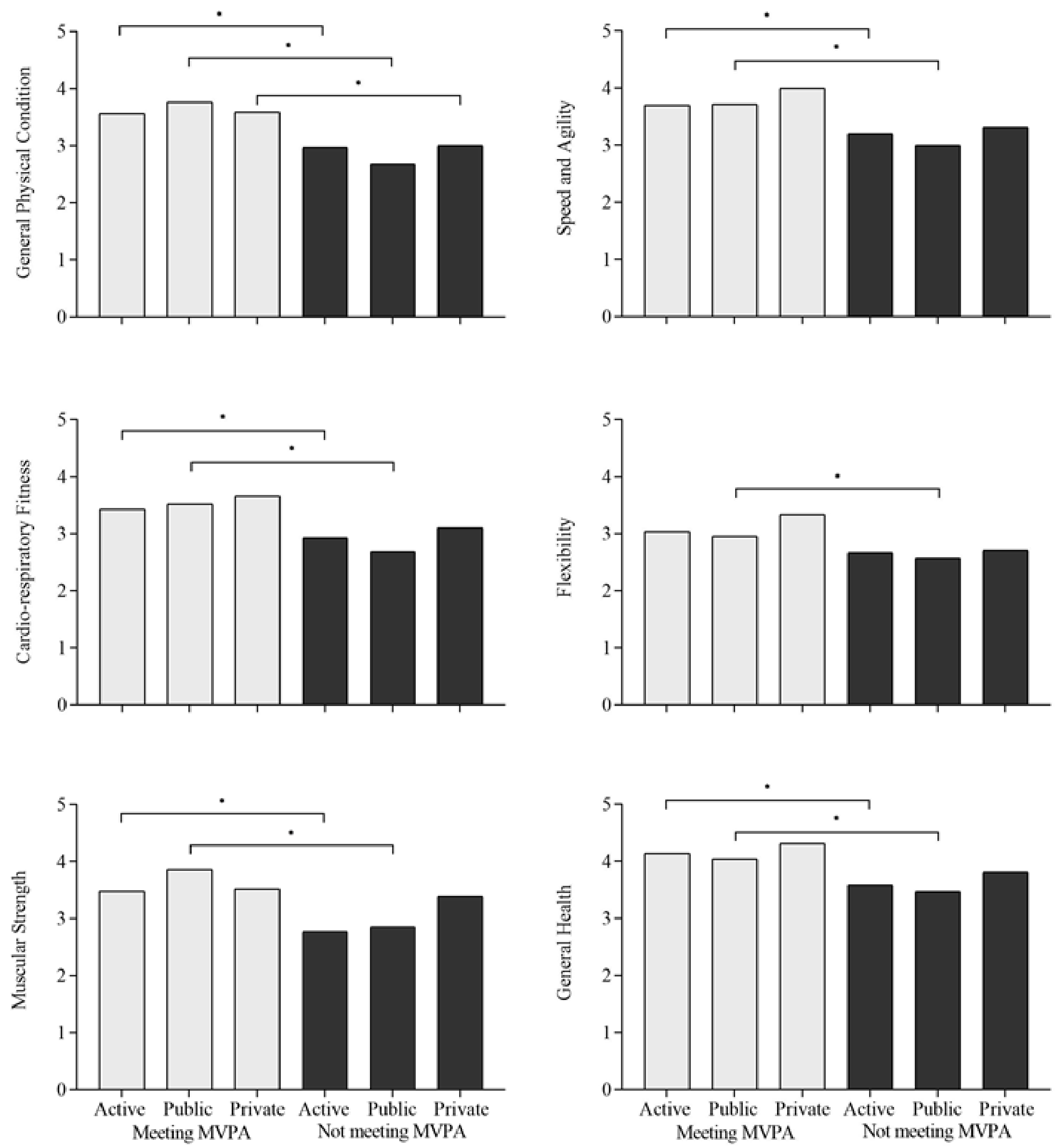

Figure 4. Associations between mode of commuting and meeting MVPA recommendations, with physical fitness in men.

Notes: (MVPA) moderate to vigorous physical activity; (*) Significant differences with p<0.05.

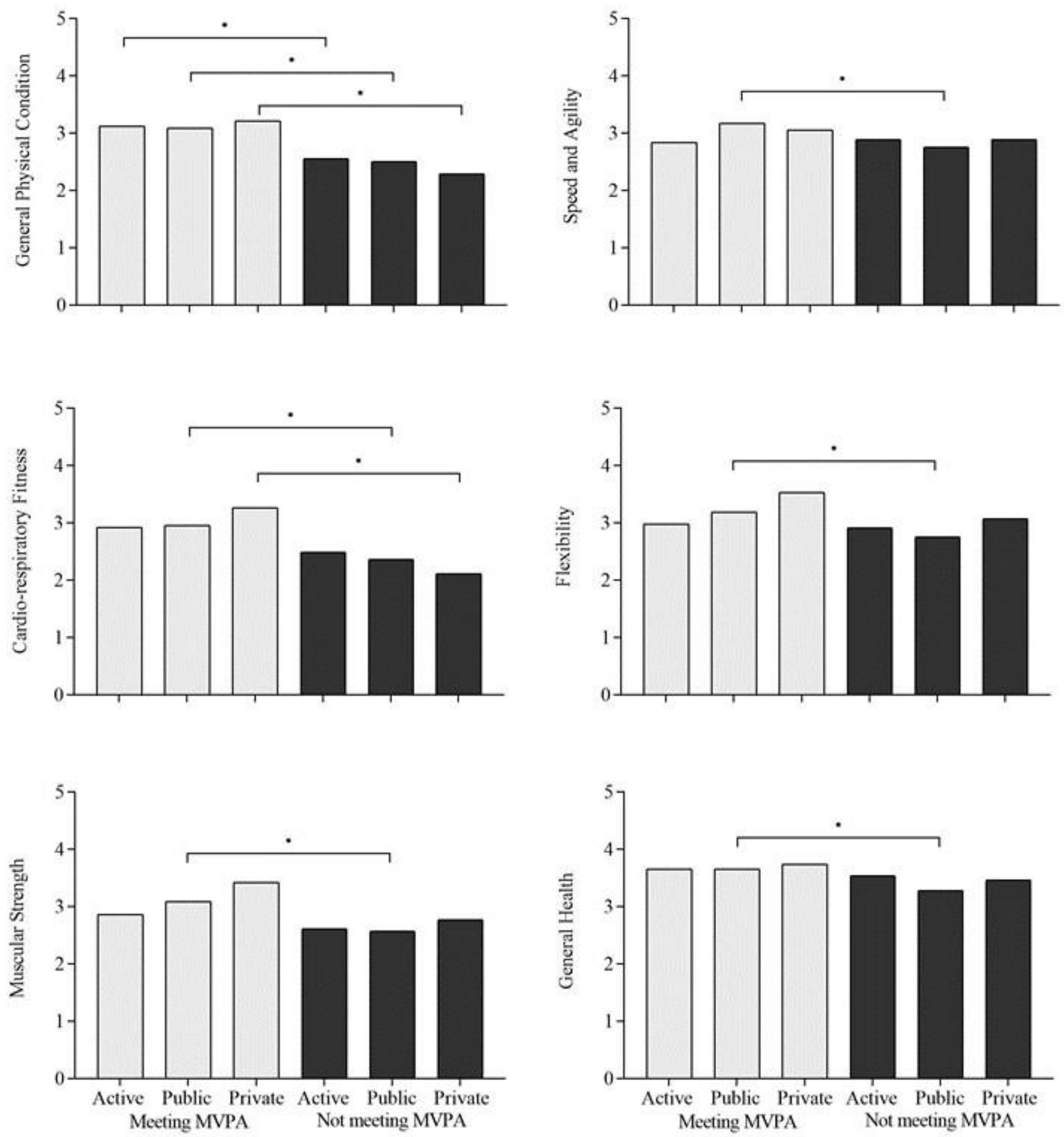

Figure 5. Associations between mode of commuting and meeting MVPA recommendations, with physical fitness in women.

Notes: (MVPA) moderate to vigorous physical activity; (*) Significant differences with $p<0.05$.

Section II

Study 3 and Study 4: Patterns

The commuting patterns to and from university in Spanish students by gender are shown in **Figure 6**. The main mode of commuting to and from university was by car, without significant differences between women and men. The second mode of commuting most used was walking in men, and public bus in women. Three statistical differences in the mode of commuting to and from university by public bus, cycling, and motorcycle were found, with men showing lower percentages in public bus (to: $p=0.003$ and from: $p=0.001$) and higher percentages in cycling (to: $p=0.007$ and from: $p=0.013$) and motorcycle (to and from: $p<0.001$) than women.

The mode of commuting categorized, the sociodemographic characteristics, PA, and physical fitness by gender are presented in **Table 8**. There were no significant differences in the sociodemographic characteristics. In addition, men reported higher PA levels than women ($p<0.001$), and the majority of students meet the MVPA recommendations (men 84.4% and women 77.2%; $p=0.004$). Finally, men displayed higher physical fitness than women, except in flexibility (all, $p<0.001$).

According to the sample of the Study II, the descriptive characteristics according to the mode of commuting to university are displayed in **Table 9**. Most of the sample were women (65.1%) and had a medium SES (58.7%). Students living in university residence were mostly active commuters ($p=0.002$). There were no significant differences in any body composition variable (all, $p>0.05$).

The medians and interquartile ranges of the self-reported measures of commuting variables to and from the university are presented in **Table 10**. In both trips (to and from university), all the commuting variables (commuting time, distance, and speed) were lower for active commuters than for both motorised modes, except for commuting EE per min (all, $p<0.001$). Public transport users present statistical differences from active commuters and private transport users in the total commuting EE ($p<0.05$).

The medians and interquartile ranges of device-measured time in PA levels and sitting time per weekday in both trips (to and from university) by mode of commuting are shown in **Table 11**.

Overall, to and from university, there were significant differences in MVPA level and light PA level between active commuters and both motorised modes ($p<0.05$). Sitting time presented significant differences ($p<0.05$) to and from university on weekdays (except on Thursday from university) between active commuter's vs public and/or private transport users, and the medians of active commuters were always close to zero (vs public and/or private transport with medians between 10 to 34 min).

The average device-measured time (min/day, Monday to Friday) in PA levels and sitting time in both trips (to and from university) by mode of commuting are illustrated in **Figure 7**. The Figure reveals that in both trips (to and from university), student who use active commuting present significant differences ($p<0.05$) with both motorised modes in all PA levels and sitting time.

Vigorous PA was excluded from the **Table 11** and the **Figure 7** since its median value was generally zero in the three modes of commuting.

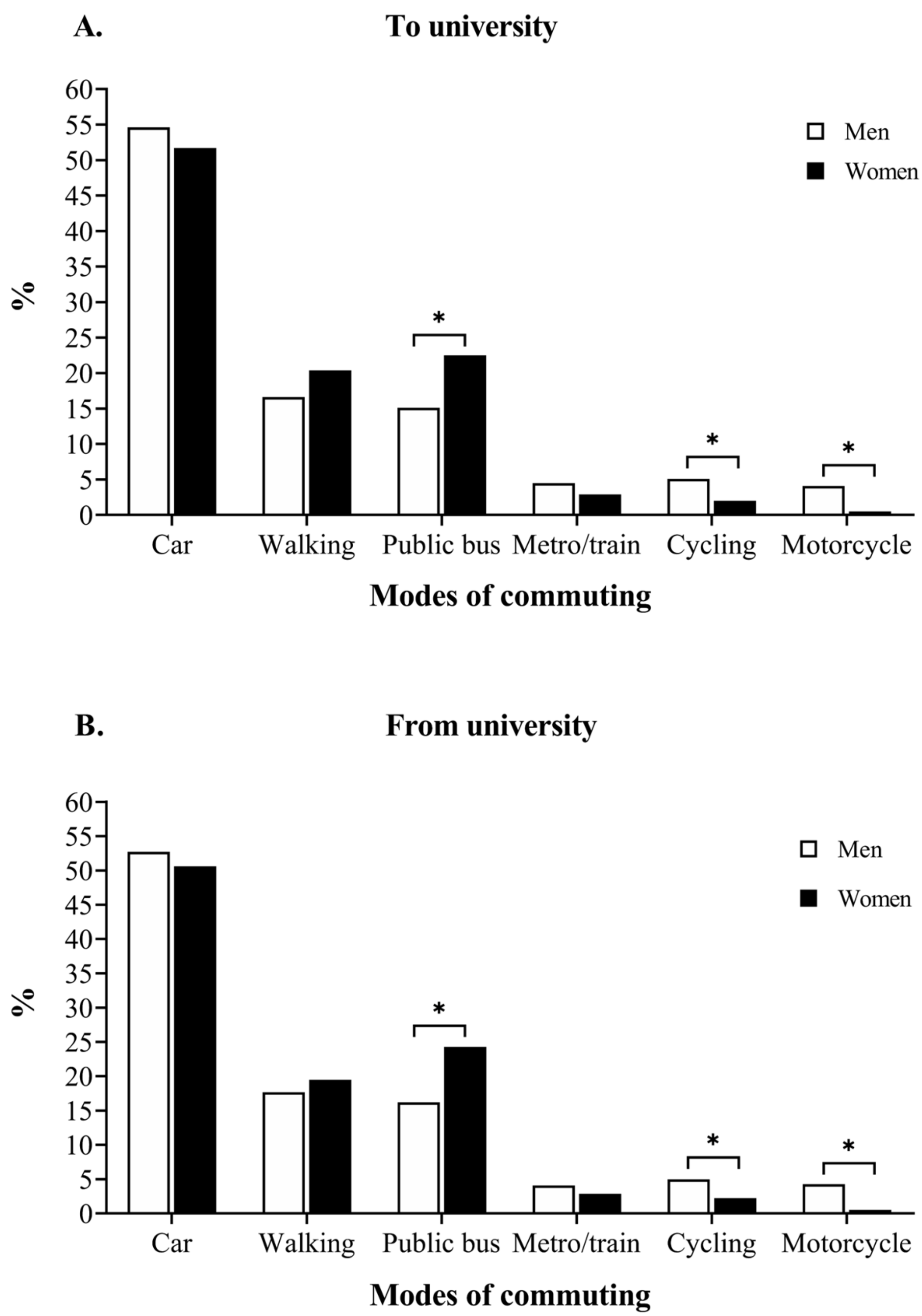

Figure 6. Commuting patterns A) to university and B) from university in university students by gender.

Notes: (*) Significant differences with $p<0.05$.

Table 8. Mode of commuting, sociodemographic characteristics, physical activity levels, and physical fitness of participants by gender.

	All (n= 1012)	Men (n= 469)	Women (n= 543)	*p* -value
Classified Mode of commuting				
Active commuting	240 (23.7)	113 (24.1)	127 (23.4)	
Public transport	245 (24.2)	96 (20.5)	149 (27.4)	0.030
Private transport	527 (52.1)	260 (55.4)	267 (49.2)	
Sociodemographic characteristics				
Age (years)	27.3 ± 6.0	27.7 ± 6.3	27.0 ± 5.7	0.081
Younger (18-25)	591 (58.4)	268 (57.1)	323 (59.5)	0.451
Older (>26)	421 (41.6)	201 (42.9)	220 (40.5)	
Type of residence				
Family residence	687 (67.9)	325 (69.3)	362 (66.7)	0.372
University residence	325 (32.1)	144 (30.7)	181 (33.3)	
Socioeconomic status				
High	299 (29.5)	145 (30.9)	154 (28.4)	
Medium	530 (52.4)	251 (53.5)	279 (51.4)	0.147
Low	183 (18.1)	73 (15.6)	110 (20.3)	
Distance to university				
> 5 km	675 (66.7)	313 (66.7)	362 (66.7)	
2 – 5 km	166 (16.4)	75 (16.0)	91 (16.8)	0.922
< 2 km	171 (16.9)	81 (17.3)	90 (16.5)	
Physical Activity				
PA Levels				
Light	139 (13.7)	57 (12.2)	82 (15.1)	
Moderate	212 (20.9)	65 (13.8)	147 (27.1)	<0.001
Vigorous	661 (65.4)	343 (74.0)	314 (57.8)	
MVPA recommendations				
Not meeting	197 (19.5)	73 (15.6)	124 (22.8)	0.004
Meeting	815 (80.5)	396 (84.4)	419 (77.2)	
Physical Fitness				
General Physical Condition	3.2 ± 0.8	3.4 ± 0.9	3.0 ± 0.8	<0.001
Cardiorespiratory Fitness	3.0 ± 0.9	3.3 ± 1.0	2.8 ± 0.9	<0.001
Muscular Strength	3.0 ± 0.8	3.3 ± 0.8	2.8 ± 0.8	<0.001
Speed and Agility	3.1 ± 0.9	3.4 ± 0.9	3.0 ± 0.8	<0.001
Flexibility	2.9 ± 1.0	2.8 ± 0.9	3.0 ± 1.0	<0.001
General Health	3.5 ± 0.7	3.6 ± 0.8	3.4 ± 0.7	<0.001

Notes: Data are expressed as mean ± standard deviation for continuous variables and as frequencies and percentages for categorical variables; (PA) physical activity; (MVPA) moderate to vigorous physical activity.

Table 9. Descriptive characteristics according to students´ mode of commuting to university.

	Mode of commuting to university				
	All n = 63 (100)	Active n = 18 (28.6)	Public n = 13 (20.6)	Private n = 32 (50.8)	*p*-value
Sociodemographic characteristics					
Women	41 (65.1)	11 (61.1)	11 (73.3)	19 (63.3)	0.735
Socioeconomic status					
High	18 (28.6)	4 (22.2)	2 (13.3)	12 (40.0)	
Medium	37 (58.7)	12 (66.7)	9 (60.0)	16 (53.3)	0.172
Low	8 (12.7)	2 (11.1)	4 (26.7)	2 (6.7)	
Type of residence					
Family residence	40 (63.5)	6 (33.3)[a]	9 (60.0)	25 (83.3)[a]	0.002
University residence	23 (36.5)	12 (66.7)[a]	6 (40.0)	5 (16.7)[a]	
Body composition					
Height (cm)	165.4 ± 8.5	165.9 ± 7.4	162.4 ± 9.0	166.3 ± 8.8	0.683
Weight (kg)	61.8 ± 11.6	62.7 ± 9.2	62.8 ± 18.3	60.8 ± 9.6	0.686
BMI (kg/m²)	22.4 ± 2.8	22.7 ± 2.3	23.4 ± 4.6	21.8 ± 2.1	0.234

Notes: Data are expressed as mean ± standard deviation for continuous variables and as frequencies and percentages for categorical variables; (cm) centimetres; (kg) kilograms; (kg/m²) kilograms/metres²; (BMI) Body mass index; and common superscripts indicate significant differences (p<0.05) between the groups with the same letter after Mann-Whitney test.

Table 10. Self-reported measures of commuting variables to and from the university of the participants.

	All (n = 63)			
	To university	*p*-value	From university	*p*-value
Commuting variables	Median (IQRs)		Median (IQRs)	
Commuting time (min)				
Private transport	9.5 (3.0)[a,b]		10.0 (3.0)[a,b]	
Public transport	25.0 (30.0)[a]	<0.001	25.0 (25.0)[a]	<0.001
Active commuting	25.0 (18.7)[b]		25.0 (20.0)[b]	
Commuting distance (km)				
Private transport	0.7 (0.3)[a,b]		0.7 (0.3)[a,b]	
Public transport	11.0 (19.3)[a]	<0.001	10.1 (10.8)[a]	<0.001
Active commuting	18.2 (22.4)[b]		19.3 (21.7)[b]	
Commuting speed (km/hr)				
Private transport	4.8 (1.2)[a,b]		4.8 (1.2)[a,b]	
Public transport	27.3 (13.6)[a]	<0.001	26.2 (15.4)[a]	<0.001
Active commuting	45.5 (31.3)[b]		46.0 (32.4)[b]	
Energy expenditure per min (METs)				
Private transport	3.7 (0.9)[a,b]		3.7 (0.3)[a,b]	
Public transport	2.1 (0.5)[a,c]	<0.001	2.1 (0.5)[a,c]	<0.001
Active commuting	1.3 (0.0)[b,c]		1.3 (0.0)[b,c]	
Total energy expenditure (METs)				
Private transport	30.1 (11.5)[a]		30.1 (10.7)[a]	
Public transport	51.2 (39.0)[a,b]	0.001	51.2 (32.5)[a,b]	0.006
Active commuting	32.5 (24.3)[b]		32.5 (26.0)[b]	

Notes: Data are expressed as median and (IQRs) interquartile ranges [Q3-Q1]; (min) minutes; (km) kilometres; (hr) hours; (METs) metabolic equivalents; and common superscripts indicate significant differences (p<0.05) between the groups with the same letter after Mann-Whitney test.

Table 11. Device measure for each mode of commuting per weekday to and from university of commuting variables, physical activity and sitting time of the participants.

	Mode of commuting To university				Mode of commuting From university			
	Active n = 18 (28.6)	Public n = 13 (20.6)	Private n = 32 (50.8)	*p*-value	Active n = 18 (28.6)	Public n = 14 (22.2)	Private n = 31 (49.2)	*p*-value
Min of*								
	Median (IQRs)	Median (IQRs)	Median (IQRs)		Median (IQRs)	Median (IQRs)	Median (IQRs)	
Monday								
MVPA	8.5 (4.2)[a,b]	2.0 (6.0)[a]	1.0 (3.0)[b]	<0.001	6.0 (7.0)[a,b]	2.5 (5.0)[a]	0.0 (3.0)[b]	<0.001
Moderate	8.0 (5.2)[a,b]	2.0 (6.0)[a]	1.0 (2.7)[b]	0.001	5.5 (6.7)[a,b]	2.5 (5.0)[a]	0.0 (3.0)[b]	<0.001
Light	2.0 (3.5)[a,b]	8.0 (11.0)[a]	8.5 (9.2)[b]	<0.001	4.0 (8.0)[b]	10.5 (3.5)	12.0 (9.0)[b]	0.020
Sitting time	0.0 (2.0)[a,b]	19.0 (14.0)[a]	18.0 (15.2)[b]	<0.001	2.0 (5.2)[a,b]	17.0 (11.5)[a]	12.0 (18.0)[b]	<0.001
Tuesday								
MVPA	7.0 (4.0)[a,b]	1.0 (5.7)[a]	1.0 (3.0)[b]	<0.001	7.0 (4.5)[b]	2.0 (6.5)	1.0 (4.2)[b]	0.005
Moderate	5.0 (4.0)[a,b]	1.0 (5.7)[a]	1.0 (3.0)[b]	0.001	7.0 (4.0)[b]	2.0 (6.5)	1.0 (4.2)[b]	0.005
Light	3.0 (5.0)[a,b]	7.5 (9.5)[a]	8.0 (8.0)[b]	0.001	6.0 (7.5)[b]	8.0 (8.0)	11.0 (13.2)[b]	0.009
Sitting time	0.0 (0.0)[a,b]	23.5 (12.5)[a]	15.0 (16.0)[b]	<0.001	1.0 (6.0)[a,b]	15.0 (19.0)[a]	18.0 (12.2)[b]	<0.001
Wednesday								
MVPA	7.0 (5.7)[b]	2.1 (22.0)	1.0 (2.0)[b]	0.003	7.0 (11.0)[b]	1.6 (11.5)	0.5 (4.7)[b]	0.050
Moderate	4.5 (7.5)[b]	2.0 (19.0)	1.0 (2.0)[b]	0.010	6.0 (12.0)[b]	1.5 (5.5)	0.5 (4.7)[b]	0.058
Light	2.0 (4.0)[a-b]	8.0 (5.0)[a]	9.0 (10.0)[b]	<0.001	7.0 (8.0)	10.0 (6.7)	9.5 (9.5)	0.281
Sitting time	0.0 (2.5)[a,b]	24.0 (15.0)[a]	17.0 (12.5)[b]	<0.001	2.0 (5.5)[a,b]	14.0 (8.2)[a]	15.5 (17.5)[b]	0.006
Thursday								
MVPA	7.0 (15.5)[a,b]	2.0 (3.5)[a]	1.0 (2.0)[b]	0.001	9.0 (20.5)	0.0 (2.0)	2.0 (4.0)	0.287
Moderate	7.0 (15.5)[a,b]	2.0 (3.5)[a]	1.0 (2.0)[b]	0.001	9.0 (20.5)	0.0 (2.0)	2.0 (4.0)	0.287
Light	2.0 (5.5)[b]	10.0 (10.5)	10.0 (9.0)[b]	0.042	0.0 (3.5)[b]	5.0 (2.0)[c]	11.0 (10.0)[b,c]	0.001
Sitting time	0.0 (0.0)[a,b]	19.0 (12.0)[a]	13.0 (16.0)[b]	0.002	1.0 (7.5)[a,b]	15.0 (16.0)[a]	20.0 (23.0)[b]	0.013
Friday								
MVPA	13.0 (6.0)[a,b]	1.5 (0.0)[a]	2.0 (4.0)[b]	0.089	7.5 (9.7)[b]	1.0 (0.0)	1.5 (4.5)[b]	0.104
Moderate	13.0 (6.0)[a,b]	1.5 (0.0)[a]	2.0 (4.0)[b]	0.089	7.5 (9.7)[b]	1.0 (0.0)	1.5 (4.5)[b]	0.104
Light	2.5 (0.0)	12.0 (6.0)	8.0 (9.5)	0.170	4.0 (13.2)	5.0 (0.0)	9.5 (15.0)	0.138
Sitting time	0.5 (0.0)[a,b]	34.0 (26.0)[a,c]	11.0 (13.5)[b,c]	0.016	0.0 (0.7)[a,b]	14.0 (13.0)[a]	10.5 (15.0)[b]	0.007

Notes: Data are expressed as median and (IQRs) interquartile ranges [Q3-Q1]; (*) Commuting-related physical activity and sitting time; (PA) physical activity; (ST) sitting time; (MVPA) moderate to vigorous physical activity; and common superscripts indicate significant differences ($p<0.05$) between the groups with the same letter after Mann-Whitney test.

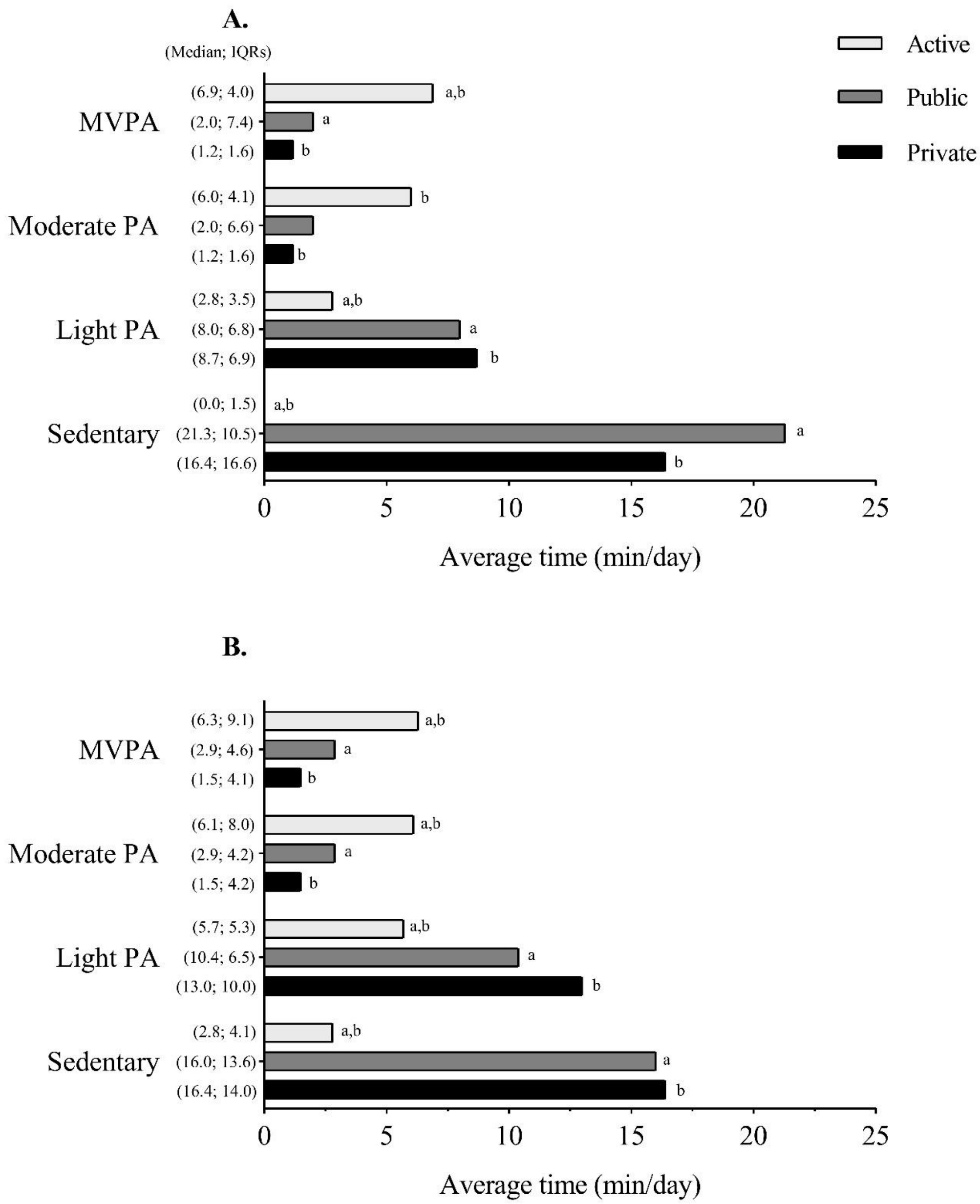

Figure 7. Average time (min/day, Monday to Friday) measured by device for each mode of commuting, A) to university and B) from university, of commuting variables, PA and sitting time of the participants.

Notes: data were expressed as medians; (IQRs) interquartile ranges [Q3-Q1]; (PA) physical activity; (MVPA) moderate to vigorous physical activity; superscripts indicate significant differences ($p<0.05$) between the groups with the same letter after Mann-Whitney test.

Study 3 and Study 4: Correlates

The mode of commuting associated with sociodemographic characteristics by gender are shown in **Table 12**. Concerning men, active commuters and public transport users were more likely to belong to low SES (both, $p<0.001$), compared to private transport users. Regarding women, active commuters were more likely to live in university residence ($p=0.010$) than private transport users, and active commuters and public transport users were more likely to belong to low and medium SES (active: $p=0.004$, and $p=0.007$, respectively; public: $p<0.001$; and $p=0.002$, respectively), compared to women private transport users. Finally, both, men and women active commuters were more likely to live closer to university, (between 2-5 km and <2 km, both, $p<0.001$).

The associations of mode of commuting with PA levels, sitting time, and physical fitness by gender are presented in **Table 13**. In men, both active commuters and public transport users were more likely to report higher muscular strength compared to private transport users ($p=0.038$ and $p=0.002$, respectively). In women, active commuters were more likely to have high PA levels ($p=0.021$), and to report a higher general physical condition, cardiorespiratory fitness, and general health ($p=0.018$, $p=0.001$, and $p=0.033$, respectively) compared to private transport users.

The results obtained in the additional analysis to provide further information about the comparison between active commuting vs. public transport are reported in **Table 14**. Regarding to the sociodemographic characteristics, similar results were showed (as well as active vs. private) in two associations (women active commuters were more likely to live in university residence ($p=0.022$) than public transport users, and men and women active commuters were more likely to live closer to university [between 2-5 km and <2 km (both, $p<0.001$)]. Concerning PA levels and physical fitness, new findings were found in men in the associations between active commuting with PA levels (active commuters were more likely to have high PA levels ($p=0.039$), and to meet the MVPA recommendations ($p=0.020$) compared to public transport users), and similar results were found in women in the associations between the mode of commuting with physical fitness.

The associations between self-reported and device measures of commuting variables, PA and sitting time, to university and from university, are shown in **Table 15** and **Table 16**, respectively. On one hand (to university), students using active commuting presented positive associations in commuting time, distance and total EE with MVPA, moderate PA, and sitting time (all $p<0.05$). Students using public transport presented two positive associations in commuting time and total EE with light PA (both, $p<0.05$). Private transport users reveal positive associations in commuting time, distance, and total EE with light PA, and sitting time (all, $p<0.05$). On the other hand (from university), students using active commuting presented positive associations in commuting time with MVPA, and moderate PA, and in distance and total EE with MVPA, moderate PA, light PA, and sitting time (all, $p<0.05$). Students using public transport presented positive associations in commuting time with light PA and sitting time (both, $p<0.05$). Finally, students using private transport showed positive associations in commuting time, distance, and total EE with light PA, and sitting time (all, $p<0.05$). In the Tables, the data obtained for commuting speed and commuting EE per minute are not presented, since no significant associations were found.

Table 12. Associations between mode of commuting with sociodemographic characteristics in university students by gender.

	Mode of commuting to university			
	Men (n=469)		Women (n=543)	
	Active	Public	Active	Public
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Sociodemographic characteristics				
Age (years)				
Younger (18-25)	Ref.	Ref.	Ref.	Ref.
Older (>26)	0.83 (0.45, 1.53)	0.52 (0.31, 1.06)	0.40 (0.21, 1.02)	0.69 (0.45, 1.05)
Type of residence				
Family residence	Ref.	Ref.	Ref.	Ref.
University residence	1.35 (0.71, 2.56)	1.21 (0.69, 2.12)	**2.23 (1.21, 4.10)**	1.02 (0.63, 1.65)
Socioeconomic status				
High	Ref.	Ref.	Ref.	Ref.
Medium	1.65 (0.81, 3.37)	1.66 (0.95, 2.93)	**2.74 (1.31, 5.71)**	**2.18 (1.33, 3.56)**
Low	**5.52 (2.19, 13.94)**	**6.10 (2.77, 13.41)**	**3.63 (1.52, 8.70)**	**3.32 (1.81, 6.08)**
Distance to the university				
> 5 km	Ref.	Ref.	Ref.	Ref.
2 – 5 km	**22.25 (10.34, 47.85)**	0.54 (0.22, 1.31)	**14.60 (7.27, 29.33)**	1.00 (0.54, 1.83)
< 2 km	**59.35 (26.61, 132.38)**	0.26 (0.05, 1.16)	**71.72 (36.69, 157.32)**	0.37 (0.10, 1.33)

Notes: analysis were adjusted for socioeconomic status and distance to university (except in the analysis when the variable was calculated). (OR) odd ratio; (CI) confidence intervals; (*) private transport was established as reference; (bold) significant association with $p<0.05$.

Table 13. Associations between mode of commuting with physical activity and physical fitness of the participants by gender.

	Mode of commuting to university			
	Men (n=469)		Women (543)	
	Active	Public	Active	Public
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Physical Activity				
PA Levels				
Light	Ref.	Ref.	Ref.	Ref.
Moderate	2.78 (0.77, 9.95)	0.75 (0.29, 1.89)	1.05 (0.38, 2.87)	1.64 (0.85, 3.15)
Vigorous	2.44 (0.83, 7.13)	0.68 (0.34, 1.38)	**2.84 (1.16, 6.89)**	1.46 (0.79, 2.67)
MVPA recommendations				
Not meeting	Ref.	Ref.	Ref.	Ref.
Meeting	1.95 (0.79, 4.83)	0.58 (0.31, 1.09)	1.51 (0.75, 3.08)	1.09 (0.67, 1.77)
Physical Fitness				
General physical condition	1.14 (0.80, 1.62)	1.14 (0.88, 1.49)	**1.56 (1.08, 2.27)**	1.05 (0.82, 1.35)
Cardiorespiratory fitness	1.09 (0.80, 1.48)	0.89 (0.70, 1.33)	**1.75 (1.24, 2.45)**	1.00 (0.80, 1.26)
Muscular strength	**1.13 (1.02, 1.66)**	**1.63 (1.19, 2.22)**	0.79 (0.56, 1.12)	0.93 (0.73, 1.19)
Speed and agility	1.14 (0.82, 1.57)	1.02 (0.78, 1.32)	0.81 (0.58, 1.14)	1.13 (0.89, 1.43)
Flexibility	1.05 (0.76, 1.45)	1.00 (0.78, 1.29)	0.85 (0.60, 1.07)	1.05 (0.86, 1.28)
General health	1.07 (0.67, 1.50)	0.93 (0.69, 1.25)	**1.58 (1.03, 2.43)**	0.83 (0.62, 1.11)

Notes: analysis were adjusted for socioeconomic status and distance to university (except in the analysis when the variable was calculated). (OR) odd ratio; (CI) confidence intervals; (MVPA) moderate to vigorous physical activity; (*) private transport was established as reference; (bold) significant association with $p<0.05$.

Table 14. Associations between mode of commuting (active vs public) with sociodemographic characteristics, physical activity, and physical fitness of the participants by gender.

	Active commuting to university*	
	Men (n=469)	Women (n=543)
	OR (95% CI)	OR (95% CI)
Sociodemographic characteristics		
Age (years)		
Younger (18-25)	Ref.	Ref.
Older (>26)	1.60 (0.77, 3.29)	0.59 (0.29, 1.14)
Type of residence		
Family residence	Ref.	Ref.
University residence	1.11 (0.52, 2.38)	**2.16 (1.11, 4.20)**
Socioeconomic status		
High	Ref.	Ref.
Medium	0.99 (0.42, 2.33)	1.09 (0.42, 2.80)
Low	0.90 (0.32, 2.56)	1.25 (0.55, 2.83)
Distance to the university		
> 5 km	Ref.	Ref.
2 – 5 km	**40.85 (14.88, 112.12)**	**14.55 (6.85, 30.89)**
< 2 km	**227.48 (49.01, 955.74)**	**193.52 (54.51, 687.05)**
Physical Activity		
PA Levels		
Light	Ref.	Ref.
Moderate	3.07 (0.86, 15.89)	0.64 (0.21, 1.91)
Vigorous	**3.55 (1.06, 11.79)**	1.94 (0.73, 5.16)
MVPA recommendations		
Not meeting	Ref.	Ref.
Meeting	**3.33 (1.20, 9.22)**	1.39 (0.65, 2.99)
Physical Fitness		
General physical condition	1.00 (0.67, 1.49)	**1.66 (1.11, 2.47)**
Cardiorespiratory fitness	1.22 (0.85, 1.74)	**1.74 (1.20, 2.50)**
Muscular strength	0.69 (0.44, 1.09)	0.84 (0.58, 1.23)
Speed and agility	1.11 (0.76, 1.62)	0.72 (0.49, 1.04)
Flexibility	1.04 (0.72, 1.51)	0.76 (0.56, 1.04)
General health	1.08 (0.68, 1.70)	**1.89 (1.20, 3.00)**

Notes: analysis were adjusted for socioeconomic status and distance to university (except in the analysis when the variable was calculated); (OR) odd ratio; (CI) confidence intervals; (MVPA) moderate to vigorous physical activity; (*) public transport was established as reference; (bold) significant association with $p<0.05$.

Table 15. Associations between self-reported variables of commuting variables to university and device-measured time of PA and sitting time.

	Commuting variables to university								
	Active			Public			Private		
	Time	Distance	EE	Time	Distance	EE	Time	Distance	EE
	Beta (95% CI)	*Beta* (95% CI)	*Beta* (95% CI)	*Beta* (95% CI)	*Beta* (95% CI)	*Beta* (95% CI)	*Beta* (95% CI)	*Beta* (95% CI)	*Beta* (95% CI)
Min of *									
MVPA	**0.08 (0.04, 1.25)**	**0.01 (0.00, 0.02)**	**3.70 (1.98, 5.42)**	0.17 (-1.45, 1.81)	-0.20 (-1.21, 0.81)	0.23 (-1.89, 2.35)	-0.08 (-1.12, 0.96)	-0.20 (-1.30, 0.90)	-0.10 (-1.46, 1.25)
Moderate	**1.08 (0.70, 1.47)**	**0.07 (0.03, 0.11)**	**3.40 (1.74, 5.06)**	0.15 (-1.59, 1.90)	-0.23 (-1.31, 0.84)	0.20 (-2.07, 2.47)	-0.07 (-1.12, 0.97)	-0.19 (-1.30, 0.90)	-0.09 (-1.45, 1.27)
Light	0.20 (-0.94, 1.35)	0.30 (-0.06, 0.12)	0.97 (-3.07, 5.02)	**1.67 (0.34, 2.99)**	0.80 (-0.12, 1.73)	**2.17 (0.45, 3.89)**	**1.35 (0.79, 1.92)**	**1.24 (0.59, 1.89)**	**1.76 (1.03, 2.49)**
Sitting time	**0.44 (0.03, 0.86)**	**0.03 (0.00, 0.07)**	**1.64 (0.21, 3.08)**	0.78 (-0.58, 2.14)	0.05 (-0.16, 0.28)	1.01 (-0.76, 2.79)	**0.92 (0.70, 1.14)**	**0.68 (0.34, 1.03)**	**1.20 (0.91, 1.49)**

Notes: (EE) Energy expenditure; (p/m) per min; (Beta) Unstandardized Beta coefficient; (95% CI) 95% Confidence Intervals; (*) Commuting-related physical activity and sitting time; (PA) physical activity; (ST) sitting time; (MVPA) moderate to vigorous physical activity; (bold) Significant differences with $p<0.05$.

Table 16. Associations between self-reported variables of commuting variables from university and device-measured time of PA and sitting time.

	Commuting variables from university								
	Active			Public			Private		
	Time	Distance	EE	Time	Distance	EE	Time	Distance	EE
	Beta (95% CI)	*Beta* (95% CI)	*Beta* (95% CI)	*Beta* (95% CI)	*Beta* (95% CI)	*Beta* (95% CI)	*Beta* (95% CI)	*Beta* (95% CI)	*Beta* (95% CI)
Min of *									
MVPA	**0.87 (0.41, 1.33)**	**0.07 (0.03, 0.10)**	**3.16 (1.47, 4.85)**	0.36 (-1.52, 2.25)	0.08 (-1.06, 1.23)	0.47 (-1.98, 2.93)	-0.02 (-1.00, 0.94)	-0.12 (-1.13, 0.88)	-0.03 (-1.30, 1.23)
Moderate	**0.91 (0.46, 1.35)**	**0.07 (0.03, 0.11)**	**3.35 (1.75, 4.96)**	0.39 (-1.86, 2.65)	0.07 (-1.30, 1.44)	0.51 (-2.43, 3.45)	-0.02 (-1.00, 0.95)	-0.12 (-1.13, 0.88)	-0.03 (-1.30, 1.23)
Light	0.60 (-0.02, 1.22)	**0.05 (0.00, 0.10)**	**2.47 (0.29, 4.65)**	**1.67 (0.30, 3.05)**	0.67 (-0.28, 1.63)	**2.18 (0.39, 3.97)**	**0.75 (0.08, 1.43)**	**0.89 (0.21, 1.56)**	**0.98 (0.11, 1.85)**
Sitting time	0.34 (-0.35, 0.71)	**0.34 (0.00, 0.06)**	**1.38 (0.05, 2.71)**	**0.93 (0.70, 1.80)**	0.47 (-0.08, 1.03)	**1.22 (0.09, 2.34)**	**1.01 (0.68, 1.33)**	**0.58 (0.11, 1.05)**	**1.31 (0.89, 1.73)**

Notes: (EE) Energy expenditure; (p/m) per min; (Beta) Unstandardized Beta coefficient; (95% CI) 95% Confidence Intervals; (*) Commuting-related physical activity and sitting time; (PA) physical activity; (ST) sitting time; (MVPA) moderate to vigorous physical activity; (bold) Significant differences with $p<0.05$.

Section III

Study 5. Patterns and Correlates

The lifestyle behaviour patterns assessed are shown in **Table 17.** The average sleep duration was 6.6 ± 1.0 hours, and most of the students had daily breakfast (75.4%). Additionally, students reported spending an average of 132.1 ± 181.5 min/week on vigorous PA, 58.4 ± 67.5 min/week on moderate PA, and 373.5 minutes/day sitting, and mostly of them used motorised transport (74.8%). Finally, most students did not self-report a high perception of cardiorespiratory fitness and muscular strength (all, <30%).

The silhouette measure of cohesion and separation was higher than 0.5, which denotes good cluster quality cohesion and separation. The characteristics of the three different lifestyle patterns identified are displayed in **Table 18**. First, 24.5% grouped in Cluster 1 reported less sleep duration, skipping breakfast, low vigorous and moderate PA, medium sitting time, and mostly motorised transport use. Second, 56.8% of Cluster 2 showed a medium sleep duration, daily breakfast, medium vigorous and moderate PA, less sitting time, and motorised transport use. Third, 18.7% grouped in Cluster 3 revealed more sleep duration, daily breakfast, high vigorous and moderate PA, more sitting time, and active commuting use.

The different lifestyle behaviour patterns established associated with the physical fitness components are illustrated in **Figure 8**. Students in Cluster 2 were more likely to report higher cardiorespiratory fitness (p=0.015) and muscular strength (p=0.038) than students in Cluster 1 (Ref.). Additionally, students in Cluster 2 had significant odds of reporting both high cardiorespiratory fitness and muscular strength (p=0.006) compared to students in Cluster 1. Finally, students in Cluster 3 were significantly more likely to report higher cardiorespiratory fitness (p=0.038) than students in Cluster 1 (Ref.).

Table 17. Describe characteristics, lifestyle behaviour patterns, and perceived physical fitness components of participants.

	All (n= 2269)
Describe characteristics	
Age	26.8 ± 6.0
Gender	
Women	1202 (53.0)
Men	1067 (47.0)
Country of residence	
Chile	1257 (55.4)
Spain	1012 (44.6)
Lifestyle behaviours	
Sleep duration (hour/day)	6.6 ± 1.0
Breakfast status	
Daily breakfast	1711 (75.4)
Skipping breakfast	558 (24.6)
Activity intensity levels	
Vigorous PA (min/week)	132.1 ± 181.5
Moderate PA (min/week)	58.4 ± 67.5
Sitting time (min/day)	373.5 ± 212.5
Classified mode of commuting	
Active commuting	571 (25.2)
Motorised transport	1698 (74.8)
Physical fitness components	
High cardiorespiratory fitness	642 (28.3)
High muscular strength	646 (28.5)
High cardiorespiratory fitness and muscular strength	380 (16.7)

Notes: Data are expressed as mean ± standard deviation for continuous variables and as frequencies and percentages for categorical variables; (PA) physical activity; (min) minutes.

Table 18. Clustering of the different lifestyle behaviour patterns of participants.

	Cluster 1 n= 527 (24.5%)	Cluster 2 n= 1288 (56.8%)	Cluster 3 n=424 (18.7%)
Lifestyle behaviours			
Sleep duration (hour/day)	6.4 ± 1.2	6.7 ± 0.9	6.9 ± 1.0
Breakfast status			
Daily breakfast	-	1287 (99.9)	424 (100.0)
Skipping breakfast	557 (100.0)	1 (0.1)	-
Activity intensity levels			
Vigorous PA (min/week)	93.2 ± 148.5	143.2 ± 187.8	149.8 ± 193.9
Moderate PA (min/week)	55.7 ± 66.4	56.9 ± 64.0	66.6 ± 77.9
Sitting time	376.9 ± 210.0	367.4 ± 208.2	387.6 ± 228.1
Classified mode of commuting			
Active commuting	147 (26.4)	-	424 (100.0)
Motorised transport	410 (73.6)	1288 (100.0)	-

Notes: Data are expressed as mean ± standard deviation for continuous variables and as frequencies and percentages for categorical variables; (PA) physical activity; (min) minutes.

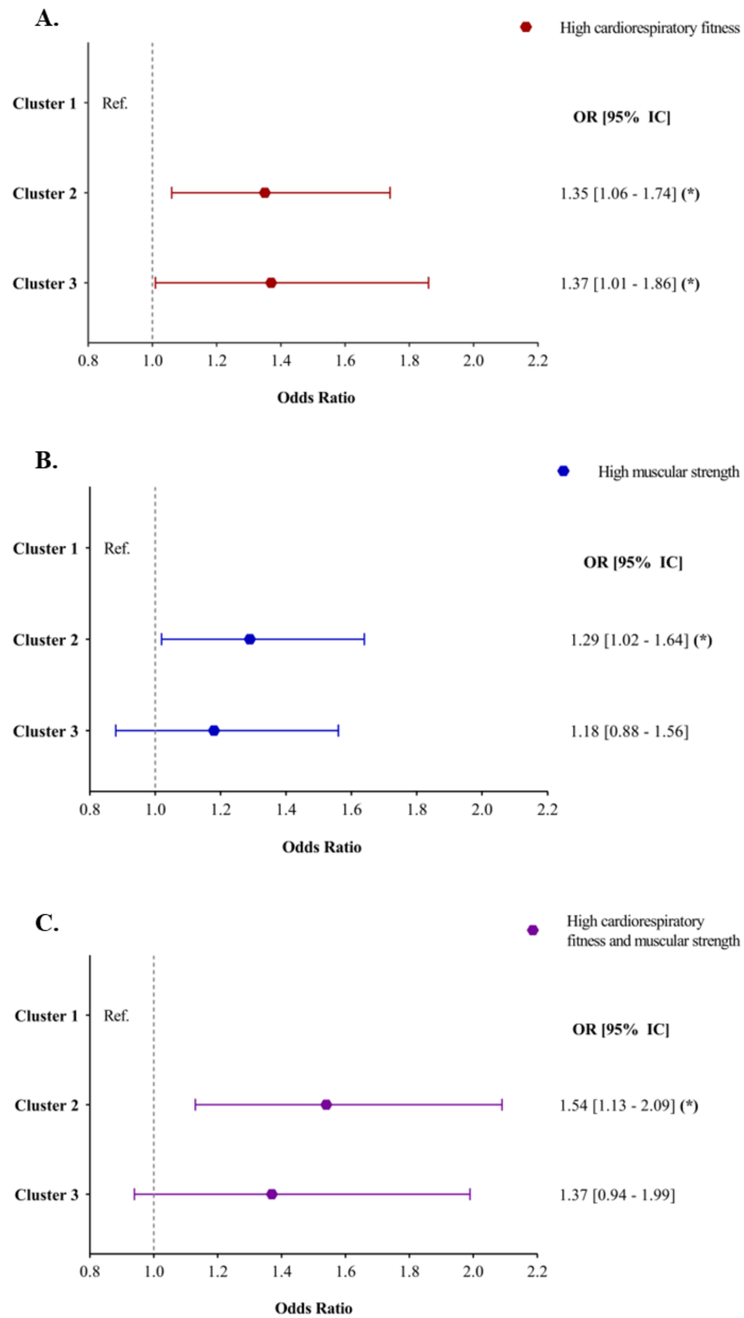

Figure 8. Associations between the different lifestyle behaviour patterns established among the high physical fitness components: A: cardiorespiratory fitness, B: muscular strength, and C: both cardiorespiratory fitness and muscular strength.

Notes: (OR) odds ratio; (95% CI) 95% confidence interval; (*) significant association with $p<0.05$. Analyses were adjusted for age, gender, and country of residence.

Study 6. Patterns and Correlates

The perceived barriers to active commuting to university by gender and country are shown in **Table 19**. Chilean women showed significant differences in five environment/safety barriers and four planning/psychosocial barriers, compared to Chilean men (all, $p<0.05$). Spanish women showed significant differences in one environment/safety barrier, and four planning/psychosocial barriers, compared to Spanish men (all, $p<0.05$). There were significant differences in the environment/safety barriers between countries. Chilean men and women were more agreed with five of the environment/safety barriers to active commuting than Spanish men and women (all, $p<0.05$). In the case of the planning/psychosocial barriers, Spanish men and women were more agreed with two barriers than Chilean men and women, respectively ($p<0.05$).

The mode of commuting associated with the perceived barriers to active commuting to university in Chilean students by gender are presented in **Table 20**. There are no significant associations between the average of the seven environmental/safety barriers and the public and private transports, nevertheless, there are significant differences in individual items that can be observed in the Table 20. Regarding to average of the seven planning/psychosocial barriers, both men and women who use private transport, were agreed with these barriers ($p=0.001$ and $p<0.001$, respectively) compared to those who used active commuting. More significant differences in individual items can be observed in Table 20.

The mode of commuting associated with the perceived barriers to active commuting to university in Spanish students by gender are presented in **Table 21**. There are no significant associations between the average of the seven environmental/safety barriers and the public and private transport, nevertheless, there are significant differences in individual items that can be observed in the Table 21. Regarding to average of the seven planning/psychosocial barriers, both men and women who use private transport ($p<0.001$, and $p=0.036$, respectively), and women who use public transport ($p=0.001$) were agreed with these barriers compared to those who used active commuting. More significant differences in individual items can be observed in Table 21.

Table 19. Perceived barriers to active commuting to university by gender and country.

	Chile (n = 1257)			Spain (n = 1012)		
	Men (n = 598)	**Women (n = 659)**	***p*– value**	**Men (n = 598)**	**Women (n = 659)**	***p*– value**
Barriers	Agree	Agree		Agree	Agree	
Environment/safety						
There are no bike lanes along the way	434 (72.6)[a]	474 (71.9)[b]	0.798	255 (48.0)[a]	276 (50.8)[b]	0.365
Usually, bike lanes are occupied by pedestrians	259 (43.3)	324 (49.2)[b]	0.038	206 (43.9)	303 (55.8)[b]	<0.001
There is too much traffic along the route	399 (66.7)[a]	467 (70.9)[b]	0.113	224 (47.8)[a]	290 (53.4)[b]	0.073
There is one or more dangerous crossings along the way	434 (72.6)[a]	540 (81.9)[b]	<0.001	290 (61.8)[a]	359 (66.1)[b]	0.157
It is unsafe because of crime to walk or bike	342 (57.2)[a]	450 (68.3)[b]	<0.001	82 (17.5)[a]	107 (19.7)[b]	0.366
There is nowhere to leave a bike safely	249 (41.6)	338 (51.3)	0.001	196 (41.8)	254 (46.8)	0.111
Streets are dangerous from cars	450 (75.3)[a]	543 (82.4)[b]	0.002	270 (57.6)[a]	335 (61.7)[b]	0.182
Average (out of 7 Environment/safety barriers)	424 (70.9)[a]	533 (80.9)[b]	<0.001	207 (44.1)[a]	286 (52.7)[b]	0.007
Planning/psychosocial						
I get too hot and sweaty to walk or bike	263 (44.0)[a]	339 (51.4)[b]	0.008	276 (58.8)[a]	345 (63.5)[b]	0.127
I have too much stuff to carry to walk or bike	343 (57.4)	455 (69.0)	<0.001	293 (62.5)	383 (70.5)	0.007
It is easier for me to travel by my car or motorbike	325 (54.3)[a]	388 (58.9)[b]	0.106	350 (74.6)[a]	415 (76.4)[b]	0.506
It involves too much planning ahead to walk or bike	188 (31.4)	285 (43.2)	<0.001	145 (30.9)	205 (37.8)	0.023
Too much time is needed	339 (56.7)	408 (61.9)	0.060	259 (55.2)	341 (62.8)	0.014
Too much physical effort is needed	229 (38.3)	308 (46.7)	0.003	153 (32.6)	238 (43.8)	<0.001
I need a car or motorbike for work purposes	199 (33.3)	220 (33.4)	0.968	191 (40.7)	250 (46.0)	0.089
Average (out of 7 Planning/psychosocial barriers)	250 (41.8)[a]	345 (52.4)[b]	<0.001	250 (53.5)[a]	330 (60.8)[b]	0.020
Total average (out of 14 barriers)	380 (63.5)[a]	495 (75.1)[b]	<0.001	251 (53.5)[a]	337 (62.1)[b]	0.006

Notes: Data are expressed as frequencies and percentages; *p* - value indicate differences between men and women within the same country; and common superscripts in the same row indicate significant differences ($p<0.05$) between men and women from different countries (differences using Bonferroni´s correction).

Table 20. Associations between mode of commuting with perceived barriers to active commuting to university of Chilean students by gender.

	Mode of commuting in Chilean students*			
	Men		Women	
	Public	Private	Public	Private
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Barriers**				
Environment/safety				
There are no bike lanes along the way	1.28 (0.67, 2.43)	0.84 (0.38, 1.85)	1.76 (0.97, 3.20)	**3.12 (1.40, 6.94)**
Usually, bike lanes are occupied by pedestrians	0.82 (0.46, 1.48)	1.30 (0.62, 2.73)	1.34 (0.78, 2.30)	1.72 (0.88, 3.34)
There is too much traffic along the route	**3.06 (1.62, 5.78)**	**2.99 (1.32, 6.76)**	1.29 (0.73, 2.28)	2.03 (0.96, 4.32)
There is one or more dangerous crossings along the way	1.63 (0.86, 3.08)	1.49 (0.66, 3.40)	1.15 (0.60, 2.22)	1.54 (0.64, 3.65)
It is unsafe because of crime to walk or bike	0.64 (0.36, 1.15)	1.44 (0.67, 3.12)	1.75 (0.98, 3.10)	**3.17 (1.48, 6.80)**
There is nowhere to leave a bike safely	1.01 (0.56, 1.81)	1.14 (0.54, 2.40)	0.98 (0.57, 1.67)	0.76 (0.39, 1.47)
Streets are dangerous from cars	1.66 (0.87, 3.17)	1.21 (0.53, 2.76)	1.62 (0.84, 3.14)	1.57 (0.68, 3.63)
Average (out of 7 Environment/safety barriers)	1.37 (0.72, 2.58)	1.34 (0.60, 3.02)	1.38 (0.72, 2.64)	1.97 (0.82, 4.71)
Planning/psychosocial				
I get too hot and sweaty to walk or bike	1.30 (0.73, 2.33)	1.54 (0.73, 3.23)	1.39 (0.81, 2.36)	0.99 (0.51, 1.91)
I have too much stuff to carry to walk or bike	0.81 (0.45, 1.44)	0.78 (0.37, 1.65)	1.66 (0.95, 2.89)	1.32 (0.66, 2.61)
It is easier for me to travel by my car or motorbike	1.20 (0.67, 2.14)	**3.61 (1.60, 8.14)**	1.26 (0.72, 2.19)	**17.83 (5.78, 54.97)**
It involves too much planning ahead to walk or bike	1.30 (0.68, 2.47)	**2.87 (1.31, 6.28)**	**3.61 (1.94, 6.72)**	**4.37 (2.11, 9.03)**
Too much time is needed	**2.72 (1.52, 4.86)**	2.04 (0.96, 4.34)	**3.01 (1.73, 5.23)**	**3.74 (1.86, 7.53)**
Too much physical effort is needed	1.51 (0.83, 2.76)	1.61 (0.75, 3.43)	**2.01 (1.15, 3.35)**	1.88 (0.95, 3.70)
I need a car or motorbike for work purposes	**0.39 (0.20, 0.75)**	**3.61 (1.58, 8.25)**	0.68 (0.38, 1.22)	**3.52 (1.76, 7.05)**
Average (out of 7 Planning/psychosocial barriers)	1.30 (0.72, 2.37)	**3.54 (1.63, 7.69)**	1.58 (0.92, 2.74)	**3.57 (1.78, 7.16)**
Total average (out of 14 barriers)	1.63 (0.90, 2.94)	**4.58 (1.87, 11.18)**	**2.30 (1.28, 4.14)**	**4.20 (1.82, 9.67)**

Notes: (OR) odd Ratio; (95% CI) 95% Confidence Intervals; (*) Active commuting was stablished as reference; (**) disagree was stablished as reference; and the analysis was adjusted for distance to university; (bold) significant association with $p<0.05$.

Table 21. Associations between mode of commuting with perceived barriers to active commuting to university of Spanish students by gender.

	Mode of commuting in Spanish students*			
	Men		Women	
	Public	Private	Public	Private
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Barriers**				
Environment/safety				
There are no bike lanes along the way	0.78 (0.39, 1.58)	0.98 (0.54, 1.79)	1.64 (0.88, 3.08)	1.31 (0.73, 2.33)
Usually, bike lanes are occupied by pedestrians	**0.47 (0.23, 0.97)**	**0.49 (0.27, 0.91)**	1.16 (0.62, 2.17)	1.37 (0.77, 2.43)
There is too much traffic along the route	0.89 (0.44, 1.79)	0.85 (0.46, 1.55)	**2.79 (1.43, 5.28)**	**2.04 (1.14, 3.67)**
There is one or more dangerous crossings along the way	0.48 (0.22, 1.01)	**0.51 (0.27, 0.98)**	1.46 (0.76, 2.78)	1.29 (0.72, 2.33)
It is unsafe because of crime to walk or bike	0.56 (0.22, 1.41)	0.67 (0.31, 1.42)	0.75 (0.33, 1.66)	0.83 (0.40, 1.74)
There is nowhere to leave a bike safely	1.02 (0.50, 2.06)	0.10 (0.55, 1.82)	1.11 (0.59, 2.06)	0.80 (0.45, 1.42)
Streets are dangerous from cars	**0.36 (0.17, 0.77)**	**0.46 (0.24, 0.89)**	**2.69 (1.41, 5.12)**	1.56 (0.88, 2.78)
Average (out of 7 Environment/safety barriers)	0.57 (0.28, 1.16)	0.67 (0.36, 1.23)	1.69 (0.91, 3.17)	1.32 (0.74, 2.34)
Planning/psychosocial				
I get too hot and sweaty to walk or bike	0.93 (0.46, 1.89)	1.06 (0.58, 1.95)	1.87 (0.98, 3.57)	**1.87 (1.03, 3.41)**
I have too much stuff to carry to walk or bike	1.04 (0.51, 2.14)	1.25 (0.68, 2.30)	1.27 (0.65, 2.49)	1.31 (0.70, 2.42)
It is easier for me to travel by my car or motorbike	0.75 (0.35, 1.61)	**2.82 (1.42, 5.59)**	1.51 (0.77, 2.97)	**3.84 (2.01, 7.32)**
It involves too much planning ahead to walk or bike	0.66 (0.30, 1.45)	1.05 (0.54, 2.03)	**4.19 (1.96, 8.95)**	**6.43 (3.14, 13.16)**
Too much time is needed	1.30 (0.64, 2.64)	**2.65 (1.45, 4.86)**	**3.28 (1.71, 6.23)**	**4.40 (2.41, 8.04)**
Too much physical effort is needed	1.19 (0.56, 2.50)	1.12 (0.58, 2.13)	**2.90 (1.46, 5.73)**	**3.60 (1.90, 6.81)**
I need a car or motorbike for work purposes	0.69 (0.33, 1.45)	1.44 (0.78, 2.67)	1.47 (0.76, 2.83)	**2.55 (1.39, 4.65)**
Average (out of 7 Planning/psychosocial barriers)	1.02 (0.50, 2.05)	**1.89 (1.04, 3.44)**	**2.85 (1.50, 5.42)**	**3.82 (2.11, 6.93)**
Total average (out of 14 barriers)	0.52 (0.275, 1.07)	0.84 (0.46, 1.55)	**2.83 (1.48, 5.38)**	**3.74 (2.06, 6.78)**

Notes: (OR) odd Ratio; (95% CI) 95% Confidence Intervals; (*) Active commuting was stablished as reference; (**) disagree was stablished as reference; and the analysis was adjusted for distance to university; (bold) significant association with $p<0.05$.

Study 7. Patterns and Correlates

The travel behaviours, SES and commuting distance between home-university of the students are shown in **Table 22**. There were significant differences in the three cases ($p<0.001$).The main mode of travel was motorised transport, but mainly public transport on the Chilean campuses (PUCV Sausalito: 82.7%, PUCV Curauma: 75.6% and UTFSM Casa Central: 54.1), and private transport on the Spanish campuses (UCA Puerto Real: 62.5%, UCA Algeciras: 52.3%, and UCA Jerez: 38.6%). The highest use of active commuting was reported at Campuses UTFSM Casa Central (45.9%) and UCA Algeciras (36.7%) from Chile and Spain, respectively. In addition, the highest SES was presented by the Spanish students from Campus Uca Puerto Real, and the lowest was presented by Chilean students from PUCV Curauma. Finally, regarding to the commuting distance (between home-university), data only available for campuses in Chile, the Campus UTFSM campus has the lowest average, while the PUCV Curauma and PUCV Sausalito campuses double its mean.

Each of the raw values, individual z-scores, and the composite score of the built environment features are available in **Table 23**. With respect to Chile, campus PUCV Curauma showed the lowest values in all the built environment features (residential density, connectivity, land-use mix, cycle lines, bicycle racks, service density, green space density, and public space ratio), and consequently, showed a negative composite score of the built environment features (-1.50). Campus UTFSM Casa Central showed four features with in-between values (land-use mix, cycle lanes, bicycle racks, and green space density), and four features with the highest values (residential density, connectivity, service density, and public space ratio) presenting a positive composite score of the built environment features (0.22). Finally, as well as Campus UTFSM Casa Central, campus PUCV Sausalito presented four features with in-between values (residential density, connectivity, service density, and public space ratio) and four features with the highest values (land-use mix, cycle lanes, bicycle racks, and green space density), obtaining a positive and the highest composite score of the built environment features (0.37) among the campuses evaluated in Chile.

Regarding to Spain, the built environment features of the campus UCA Puerto Real showed the lowest values on five characteristics (residential density, connectivity, cycle lanes, service density and public space ratio), two in-between values (land-use mix and bicycle racks) and one highest value (green space density), and in overall had a negative composite score of the built environment features (-0.29). Campus UCA Algeciras showed three lowest values (land-use mix, bicycle racks, and green space density), two in-between values (cycle lanes and service density), and three highest values (residential density, connectivity, and public space ratio) obtaining a positive composite score of the built environment features (0.25). Finally, campus UCA Jerez showed four features with in-between values (residential density, connectivity, green space density, public space ratio), and four features with the highest values (land use-mix, cycle lanes, bicycle racks, and service density) obtaining a positive and the highest composite score of the built environment features (0.85) among the campuses evaluated in Spain and Chile.

The mapping of the different built environment features of university campuses are shown in **Figures 9** (residential density, connectivity and land-use mix), and **Figure 10** (cycle lanes, bicycle racks, service density and green space density). Public space ratio was not included in Figures, as this data cannot be clearly illustrated on a map. A clearer residential density and connectivity can be seen, in particular in campuses UTFSM Casa Central (**Figure 9b**), UCA Algeciras (**Figure 9e**), and UCA Jerez (**Figure 9f**), as well as a greater number of land use-mix in campus PUCV Sausalito (**Figure 9c**). In addition, clearer cycle lanes are shown on the campuses UCA Algeciras and UCA Jerez (**Figure 10e** and **Figure 10f**), and bicycle racks on the campuses PUCV Sausalito (**Figure 10c**) and UCA Jerez (**Figure 10f**), as well as a high service density on Campus UTFSM Casa Central (**Figure 10b**) and a high green space density on campus UCA Puerto Real (**Figure 10d**).

The associations between the composite score of the built environment features of each campus and travel behaviour of students are displayed in **Table 24**. In the initial model, the odds of using active commuting in Chile were not higher in campus PUCV Sausalito compared with campus PUCV Curauma, but the odds of using active commuting were 4.76 times higher in campus UTFSM Casa Central compared with campus PUCV Curauma (p<0.001). In Spain, the odds of using active commuting were 3.84 and 3.65 times higher in campuses UCA Algeciras and UCA Jerez, respectively, compared with campus UCA Puerto Real (both, p<0.001). In the model adjusted for SES, these significant associations are maintained, and in fact, in Chile they are growing twofold. In the model adjusted for commuting distance, and both SES and commuting distance (only available in Chile), the odds of using active commuting in campus UTFSM Casa Central compared with campus PUCV Curauma are maintained.

Table 22. Travel behaviours, socioeconomic status, and commuting distance of students by university campuses.

	University campuses						
	Chile			Spain			
	PUCV Curauma (n=86)	UTFSM Casa Central (n=499)	PUCV Sausalito (n=75)	UCA Puerto Real (n=518)	UCA Algeciras (n=109)	UCA Jerez (n=132)	*p*-value
University students							
Mode of commuting							
Active commuting	13 (15.1)	229 (45.9)	10 (13.3)	68 (13.2)	40 (36.7)	47 (35.6)	<0.001
Walking	11 (12.8)	228 (45.7)	9 (11.9)	44 (8.5)	38 (34.9)	45 (34.1)	
Cycling	2 (2.3)	1 (0.2)	1 (1.4)	24 (4.7)	2 (1.8)	2 (1.5)	
Motorised transport	73 (84.9)	270 (54.1)	65 (86.7)	450 (86.8)	69 (63.3)	85 (64.4)	
Public	65 (75.6)	266 (53.3)	62 (82.7)	126 (24.3)	12 (11.0)	34 (25.8)	
Private	8 (9.3)	4 (0.8)	3 (4.0)	324 (62.5)	57 (52.3)	51 (38.6)	
Socioeconomic status	2.6 ± 1.1	4.7 ± 1.5	3.1 ± 1.1	4.9 ± 1.2	4.8 ± 1.2	4.7 ± 1.5	<0.001
Commuting distance	20.3 ± 17.0	9.5 ± 11.8	20.4 ± 16.4	N/A	N/A	N/A	<0.001

Notes: Data are presented as frequencies and percentages for categorical variables and as mean ± standard deviation for continuous variables; (PUCV) Pontificia Universidad Católica de Valparaíso; (UTFSM); Universidad Técnica Federico Santa María; (UCA) Universidad de Cádiz; (N/A) not available.

Table 23. Different values of the built environment features of university campuses in Chile and Spain.

	University campuses					
	Chile			Spain		
	PUCV Curauma	UTFSM Casa Central	PUCV Sausalito	UCA Puerto Real	UCA Algeciras	UCA Jerez
General information						
Catchment area size (m)	2,500	2,500	2,500	2,500	2,500	2,500
Environment area (Ha)	709.7364	562.6609	847.1078	504.4145	851.0314	1085.7569
Residents	6,249	49,622	39,541	16,469	80,957	97,446
Raw values of the Built environment features						
Residential density (inhab/Ha)	8,8046	88,1916	46,6776	32,6497	95,1280	89,7493
Connectivity (Intersection/km^2)	36.3515	169.0183	81.3355	99.9178	193.8823	183.1901
Land-use mix (0-1)*	0.4036	0.5938	0.9056	0.7505	0.7104	0.7687
Cycle lines (ml)	739.0	1703.0	2607.0	6509.4	10019.5	18641.8
Bicycle racks (n)	2	6	18	2	0	11
Service density (n/Ha)	8,3129	78,9107	70,1209	28,1514	44,5341	47,9849
Green Space Density (m^2/m^2)	0.0021	0.0099	0.0370	0.2340	0.0370	0.0710
Public space ratio (m^2/m^2)	0.3520	0.7440	0.5590	0.3840	0.6280	0.6160
Individual z-scores of the Built environment features						
Residential density	-1.76	0.89	-0.50	-0.97	1.12	0.94
Connectivity	-2.15	0.76	-1.16	-0.75	1.30	1.07
Land-use mix	-2.48	-0.77	2.00	0.61	0.26	0.78
Cycle lines	-0.99	-0.79	-0.61	0.17	0.87	2.60
Bicycle racks	-0.68	0.24	3.04	-0.68	-1.15	1.41
Service density	-1.71	1.18	0.82	-0.90	-0.23	-0.81
Green Space Density	-0.96	-0.87	-0.61	1.29	-0.61	-0.28
Public space ratio	-1.26	1.14	0.01	-1.07	0.43	0.35
Composite score of the built environment features	-1.50	0.22	0.37	-0.29	0.25	0.85

Notes: (m) meters; (Ha) hectare; (inhab) inhabitants; (m^2) square meters; (km^2) square kilometres; (*) units; (ml) linear metres; (n) number; (PUCV) Pontificia Universidad Católica de Valparaíso; (UTFSM); Universidad Técnica Federico Santa María; (UCA) Universidad de Cádiz.

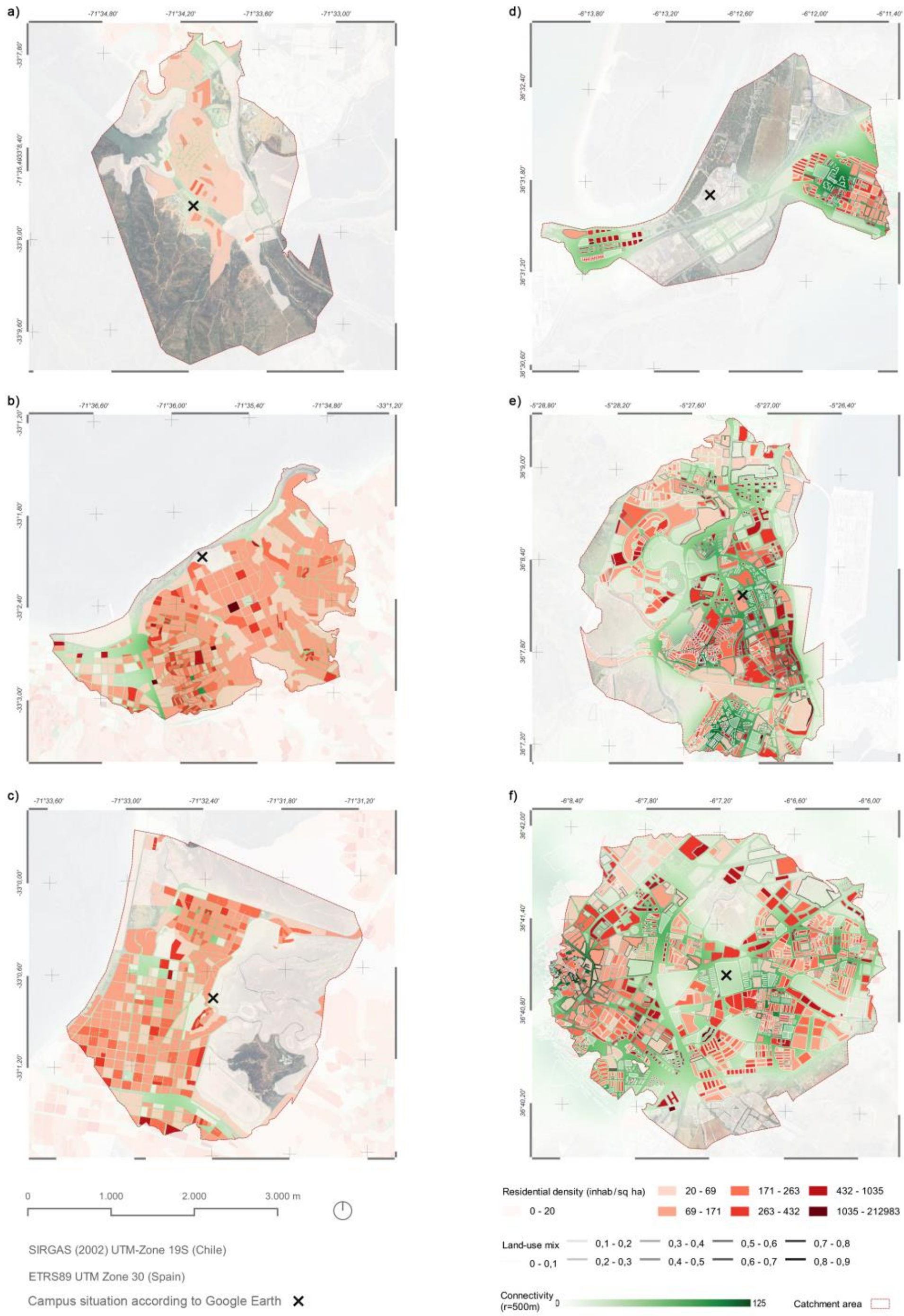

Figure 9. Residential density, connectivity, and land-use mix of university campuses, (a) is campus PUCV Curauma; (b) campus PUCV Sausalito; (c) campus UTFSM Casa Central; (d) campus UCA Puerto Real; (e) campus UCA Algeciras; and (f) campus UCA Jerez.

Notes: (SIRGAS) Geodetic Reference System for the Americas; (ETRS89) Three-Dimensional Geodetic Reference System.

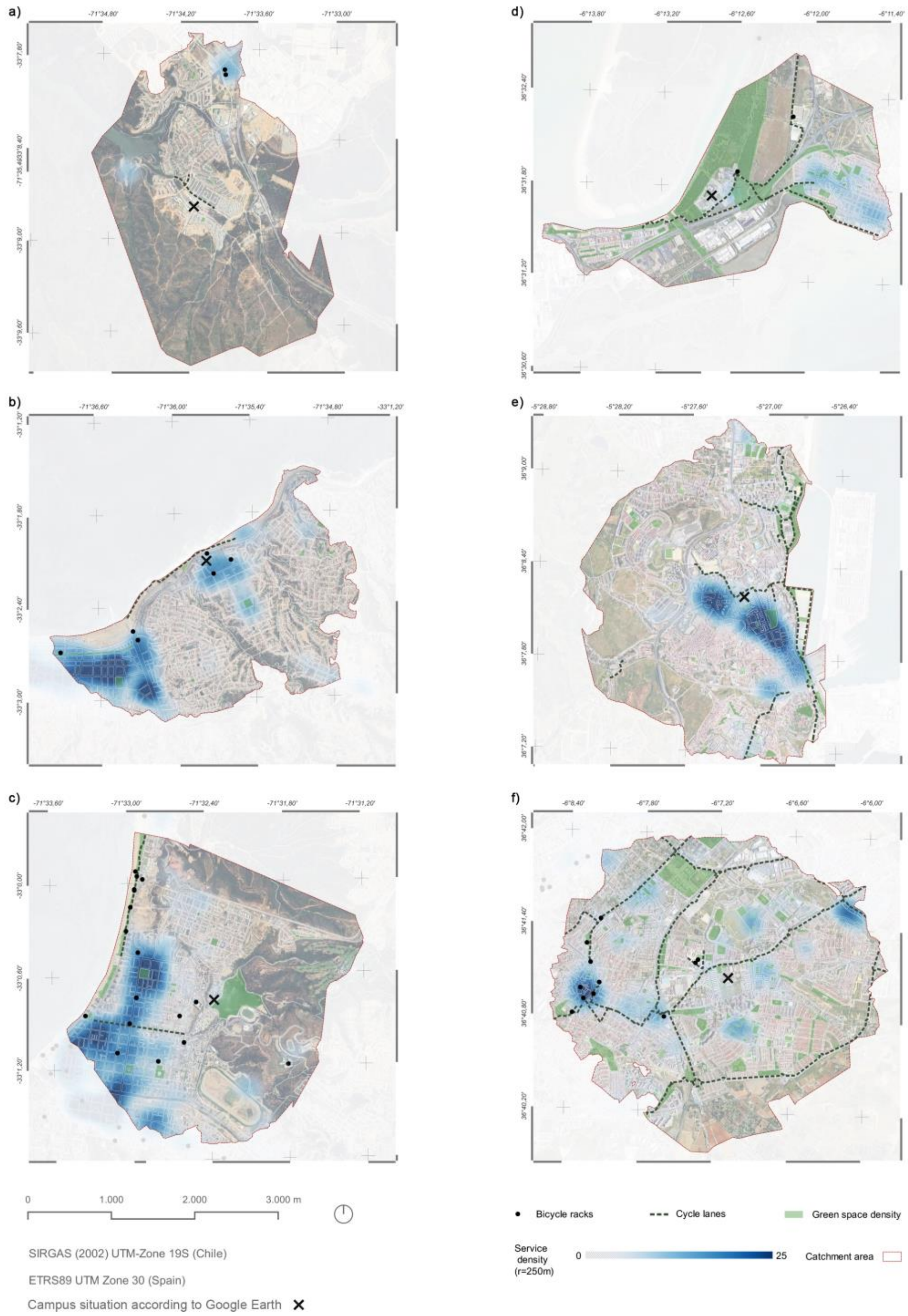

Figure 10. Cycle lanes, bicycle racks, service density, and green space density of university campuses, (a) is campus PUCV Curauma; (b) campus PUCV Sausalito; (c) campus UTFSM Casa Central; (d) campus UCA Puerto Real; (e) campus UCA Algeciras; and (f) campus UCA Jerez.

Notes: (SIRGAS) Geodetic Reference System for the Americas; (ETRS89) Three-Dimensional Geodetic Reference System.

Table 24. Associations between active commuting to university and the university campus composite score of the built environment features by country.

	Active commuting to university†					
	Chile			Spain		
	University campuses					
	PUCV Curauma	UTFSM Casa Central	PUCV Sausalito	UCA Puerto Real	UCA Algeciras	UCA Jerez
		OR (95% CI)	OR (95% CI)		OR (95% CI)	OR (95% CI)
Composite score of the BEF°	Ref.	**4.76 (2.57 – 8.82)**	0.86 (0.36 – 2.10)	Ref.	**3.84 (2.41 – 6.11)**	**3.65 (2.36 – 5.67)**
Composite score of the BEF∗	Ref.	**8.82 (4.47 – 17.41)**	0.99 (0.40 – 2.41)	Ref.	**3.82 (2.39 – 6.11)**	**3.55 (2.28 – 5.53)**
Composite score of the BEF⁑	Ref.	**4.71 (2.51 – 8.85)**	0.99 (0.40 – 2.41)	N/A	N/A	N/A
Composite score of the BEF⁂	Ref.	**8.77 (4.78 – 17.58)**	0.99 (0.40 – 2.41)	N/A	N/A	N/A

Notes: (BEF) Built Environment Features; (OR) Odds Ratio; (95% CI) 95% Confidence Interval; (†) motorised transport was established as a reference; (°) unadjusted; (∗) socioeconomic status adjusted; (⁑) commuting distance adjusted; (⁂) socioeconomic status and commuting distance adjusted; (N/A) not available; (Bold) significant association with $p < 0.05$.

A summary of the results in relation to the research objective of this Doctoral Thesis is presented in **Figure 11**.

Figure 11. Summary overview of the patterns and correlates of the studies included in this International Doctoral Thesis.

DISCUSSION

Section I

Study 1 and Study 2: Patterns

According to commuting patterns to and from university in Chilean students, the public bus was the main mode of commuting to and from university following by walking, where men showed lower percentages in the use of public bus and higher percentages in walking than women. Although active commuting was not the most common mode used, according to the literature above, the public transport may be beneficial for the university students, especially in terms of the PA levels involved. This idea can be reinforced by studies of the adult working population. For instance, one study investigated during 10 years an adult working population (over 18 years old), indicated that using public transportation services involves considerable walking (to bus stops or train stations) and could be had an important contribution in the EE (Rissel et al., 2012). In fact, a study in an English adult population (aged <35 years old) showed that public transport to and from work has an important contribution to PA levels, with 25.7 ± 14 min more per week of MVPA than adults who use private transportation (Audrey et al., 2019). However, efforts should continue to focus on increasing active commuting where possible.

Further, men present higher percentage in cycling than women, but cycling was the second least common mode of commuting to and from university for both genders. The most likely cause of this result may be due to the fact that across Latin America, the infrastructure or road safety conditions for active commuting are generally poor and/or non-existent and discourage potential users (TUMI, 2020). Expectantly, Chile is implementing new strategies in this topic and created the "Road Coexistence Law" (which aims to put all modes of commuting on the roads on an equal footing). It came into effect from the end of 2018 and projects its effects towards 2030 (CONASET, 2021). In line whit this, a recent study focused on the transport mode preferences of university students in post-pandemic period (COVID-19) showed possible significant changes in demand for transport modes, for example in a possible increase in active commuting (Bagdatli & Ipek, 2022). Therefore, could be expected that active modes such as cycling increase in a few years in Chile.

In respect of the commuting variables, a study of 49 countries on 5 continents, including Chile, indicated that it is not possible to assess to what extent the active commuting is contributing to the overall PA if other commuting variables are not measured (e.g., time, distance, speed, and EE) (Aubert et al., 2018). Whether the combination of measurements based on devices such as accelerometry and GPS is not obtainable, the possibility of estimating these variables using self-reported data becomes an opportunity. The variables calculated in this Thesis provide an estimate of information on these commuting variables, and as a result, as well as the studies of adult workers mentioned in the previous paragraph, the commuting EE per min was higher in active commuters followed by commuters using public and private transport. These values could be key to quantitatively estimate the EE in the commuting mode to university, if only self-reported information is available. In addition, this may be useful for the students themselves, since they can be interested in their EE based on their commuting behaviour.

Furthermore, it was reported that women had a lighter PA level, while men had a more vigorous PA level. In fact, a lower percentage of women reported that they were meeting MVPA recommendations compared with men. This finding are in agreement with studies in Spain and Colombia reporting that university women showed lower PA levels compared with men students (Arbinaga et al., 2019; García-Puello et al., 2018). Similar results were already observed in Chile since 2013 among university students (Rodríguez et al., 2013). Therefore, implementing programs promoting PA targeting specifically to university women are necessary. Furthermore, in the current study, men showed higher means score in all perceived fitness components, except for flexibility, compared with women students. In line with our findings, similar results were obtained in a Slovenian study, with objective measures, where women university students presented better flexibility than men (Lipošek et al., 2018). In this sense, a possible explanation for this might be that there are different stereotypes preconceived by society, such as that coordination in dance and/or higher flexibility has been associated mostly with women. Therefore, independent of the type of evaluation, women participants may consider their flexibility as a high point of their physical fitness. Nevertheless, the rate of decline in flexibility in adulthood was found to vary depending on the PA levels (Stathokostas et al., 2013). Therefore, if university women maintain their low PA levels throughout their adulthood, it is anticipated that their good flexibility score could potentially decrease.

Study 1 and Study 2: Correlates

In relation to the mode of commuting associated with sociodemographic characteristics, men and women who belonged to public university were more likely to use active commuting and public transport than students who belonged to private university. Similarly, Spanish adolescents attending public schools had three and half times higher odds for use of active commuting compared with the adolescents attending private schools (Chillón et al., 2009). In addition to this, it can be noted, that in Chile, the type of university can be a relevant socioeconomic indicator regarding the high difference between registration fees in Chilean public universities (e.g., cost of US $180) and private universities (e.g., cost of US $840), which may also explain why women who belong to medium and low SES preferred more active commuting modes, as well as men who belonged to low SES preferred more public transport, than students who belonged to high SES who preferred the use of private transport. Additionally, men and women students who lived in university residences were more likely to use active commuting than those who live in a family residence. According to this, different studies from USA indicated that type of residence was a strong indicator of the choice of mode of commuting to university, where the students who lived in the university residence tended to use active commuting (Khattak et al., 2011; Zhou, 2012). This can be explained by the distance of the residence from the university, since the average distance to university of the students living in university residences was shorter (4.4 ± 6.6 km) than that for those living in family residences (13.5 ± 13.9 km). Finally, age of the university students was positively associated with active commuting. Older men and women students were more prone to use active commuting than young students. With regard to this, it has been found that active commuting decreases from high school to the university, giving space to more motorised transport (Molina-García et al., 2015; Parra-Saldías et al., 2018).

Furthermore, the findings showed that if the commuting time and distance increased, active commuters decreased, in both men and women. According to this, it has been declared that long commuting time is associated with public and private transport (Schwanen & Dijst, 2002). Moreover, longer distances have been presented in previous studies as the main barrier to being active commuters in children and adolescents (Palma-Leal et al., 2020) and university students (Barranco-Ruiz et al., 2019; Shannon et al., 2006). Calculating the EE and quantifying variables of commuting may provide a valuable contribution to deeper understand the multiple benefits of active commuting modes to university or other frequent destinations, such as school or work. In addition, the fact of being self-reported measures, is a feasible and inexpensive way that easy the dissemination and promotion among educational establishments and public institutions. However, more studies are required to examine these measurements in detail and establish a validation with objective measures.

Additionally, active commuters were more likely to reach higher moderate and vigorous PA levels (men and women respectively), and meet the MVPA recommendations (both, men, and women), compared with those who used private transport. These results are consistent with data obtained in young population, where children and adolescents who use active commuting to school were significantly more physically active than those who use private transport, and also recorded more MVPA (Cooper et al., 2003). Likewise, adults population also showed positive associations between active commuting to work and PA (Sahlqvist et al., 2012; Yang et al., 2012), and reinforces the idea that active commuting may be a possible way to promote PA in the university population, as in any other population.

Concerning fitness, a systematic review indicated that in adult population, active commuting present important and positive association with physical fitness (cardio-respiratory fitness and muscular strength) (Henriques-Neto et al., 2020). In the study 2, men who use active commuting and public transport showed higher muscular strength compared to those who used private transport. Similar results were reported in Norwegian children and adolescents (9 to 15 years) (Østergaard et al., 2013), and Finnish men young adults (25.5 ± 5.0 years) (Vaara et al., 2020), where active commuting was positively associated with muscular strength. However, it is important to note that studies in adolescents and adults indicated that participants who use cycling present higher muscular strength that walking, a benefit, which appears to be higher because it will depend on the intensity (Andersen et al., 2009; Møller et al., 2011). In addition, women and men who use public transport reported higher flexibility and general health levels respectively, compared to students to those who used private transport. The lack of studies related to this topic in university students, makes difficult the comparison with the results of the present study. Therefore, further research concerning among the modes of commuting to university and physical fitness is necessary.

Finally, we analysed the full relationship between PA behaviours (e.g., mode of commuting and MVPA recommendations) with physical fitness. Overall, low physical fitness is reported among the university students who do not meet MVPA recommendations, regardless of the mode of commuting. Men and women who use active and public transport and met MVPA recommendations present higher physical fitness in all cases (e.g., general physical condition, cardio-respiratory fitness, muscular strength, speed and agility, flexibility [only in public transport users], and general health), compared to those not meeting the MVPA recommendations. Although the literature indicates that active commuting has the potential to generate the recommended weekly volume of PA (Shephard, 2008), and PA has been associated with physical fitness in university students (Lipošek et al., 2018), according to our results, meeting MVPA recommendations were more associated with a higher physical fitness than the mode of commuting chosen among university students. Consequently, achieving the MVPA recommendations made more relevant that adopting an active mode of commuting in order to have a better physical fitness, and it seems that they do not consider that active commuting could be a way to come closer to complying with these recommendations, and they see it as lighter behaviour. In fact, despite the information available in the literature, active commuting could be undervalued and considered as a light PA, but it should be considered as a potential behaviour with relevant contributions to the physical health status, and to other associated benefits.

These findings provide evidence that more physically active profile and a greater self-perception of physical fitness could be observed among more active commuters in university students. This indicated that new policies and public health actions could be developed to strategically target the increase of PA levels through the promotion of active commuting to and from university. However, further studies are required to examine deeper the relationships between PA levels, physical fitness, and active commuting in university students, in particular study using device-based measurement of PA and examine the contribution of active commuting modes to the MVPA recommendations. These findings could be applied in future programmes to promote PA in Chilean university population, by encouraging the use of active commuting and assessing physical fitness; and consequently, it is implication on health.

Section II

Study 3 and Study 4: Patterns

According to commuting patterns to and from university in Spanish students, the car was the main mode of commuting to and from university following by walking in men, and public bus in women. Previous studies evaluating the mode of commuting in university students in other Spanish cities (Valencia and Leon), evidenced that active commuting and public transport were the main mode of commuting to university, respectively (Molina-García et al., 2014; Pérez-Neira et al., 2020). These differences can be partly explained by different reasons. Firstly, by the characteristics of the UCA, where some of the faculties are located at long distances from city centres. On this basis, this type of suburban university campuses has been stated to become large generators of motorised commuters (Rotaris & Danielis, 2015). Secondly, by the limited or poor possibilities of intercity transport between Cádiz and the surrounding cities where the campuses are located. Several policies to discourage the use of private transport in university students have included improving public transport services (in terms of safety, punctuality, comfort and coverage), particularly when distance urges to use a motorised transport (Cattaneo et al., 2018). In this case, increasing the possibilities of public transport in Cádiz might help university students to choose it over private transport, which is associated with health (Patterson et al., 2020) and environmental benefits (Nieuwenhuijsen, 2020). In fact, according to the sociodemographic characteristics most of the students lived within a long distance from the university and in their family residences. The high use of private transport could be explained by this finding due to the fact that the distance home-university as well as lived in family residence increase the use of private transport (Barranco-Ruiz et al., 2019; Zhou, 2012). Therefore, the availability of university residences, with a shorter distance to campuses, could lead students to make more use of active commuting.

Further, as well as in Section I, men present higher percentage in cycling than women, but cycling was the second least common mode of commuting to and from university for both genders. Focusing on the city studied, Cádiz has urban planning issues compared to other cities in Spain. One of the main problems is the poor connectivity of the public transport system, in particular, public buses, which is reflected in the abundance and lack of control of private transport as well as in a lack of safety for active commuting modes (Ortega, 2005). In fact, in several areas of the city, there are some restrictions on the use of cycling, which limits their choice for transport. If there are no viable options for using public transport and the conditions for active commuting are disadvantaged, this could discourage university students. These findings may help us to understand that this Spanish city needs urban reform plans for all modes of commuting, with equal or priority conditions if the use of active commuting, such as cycling, is to be increased in view of its associated benefits. These reflections cannot be extrapolated to the rest of the Spanish cities without first considering the characteristics of each city.

In addition, both men and women reported high PA level and met MVPA recommendations. These high levels could be due to the fact that 11% of the participants in this study are from the degree of Sports Sciences, who have physical activities within the curriculum. A study in Japan found that Sport Sciences students obtained higher PA levels in class compared to students from other degrees (Shimamoto et al., 2021). Finally, as well as in Chile (Section I) men reporting higher perceived fitness than women, except in flexibility.

According to the device-measured of PA and sitting time used in this Section, active commuters reported higher EE per minute and commuting related MVPA than commuters of public and private transport, which is in concordance with the self-reported data provided in this Section and Section I. A study in university students from USA showed that an increase of EE per day may result in gradual and sustained long-term improvements in cardiometabolic health (Butler et al., 2018), and might make a large difference in the annual EE, despite travelling shorter distances in less time (Molina-García et al., 2014). Based in the findings of this Section, active commuting to and from university contributed to 66 minutes of MVPA weekly (compared with the 24 and 13 minutes in the public and private transports, respectively), which corresponds to 44% of the MVPA current recommendations. Additionally, public transport users presented higher MVPA compared to private transport, which must be due to the implication of walking to and from stations and stops than private trips, as declared (Rissel et al., 2012). However, public and private transport users presented a similar sitting time, 186 and 168 minutes per week, respectively, compared to the 14 minutes per week of active commuters. In this line, University students are considered a population at risk of sitting time in itself, since a significant proportion of their time is dedicated to study or attend lessons (Cotten & Garofalo, 2016). Furthermore, high volumes of sitting time in this population have been associated with higher health risks (Castro et al., 2018). Therefore, according to the findings, choosing between motorised options, it would be advisable to use public transport over private transport due to it is contribution to the MVPA levels, which can help to counteract the sitting time presented.

Study 3 and Study 4: Correlates

Concerning the associations, women students were more likely to use active commuting while living in university residences, and both, men and women students were more likely to use active commuting to university when they had low SES and lived in shorter distances to university. As discussed in Section I, these results corroborate the previous findings from USA (Khattak et al., 2011; Zhou, 2012), and take sense of the results presented in this study, as more university residences close to students' campuses could be related to strengthening a friendlier and healthier mobility in this population, and in this case, mainly in women. Furthermore, the associations of active commuting with SES have not been studied in depth in the university population compared to young population (children and adolescents), however, as well as Section I in Chile and in Saudi Arabia, the same trend has been found in university students (Assi et al., 2020). Considering the university to be a primary source of training for adult life (Khattak et al., 2011), the potential of using active commuting to university as urban transport must be shown to students as a viable option, and presented in terms of health and environmental benefits, regardless of SES. Secondly, as well as in Section I, regarding distance to university, the finding noted the importance of distance commuting to choose an active mode. If motorised travel demand needs to be minimised in subpopulations such as university populations, it would be important for transport engineers and planners to consider that distance seems to be the key to positive changes in commuting mode choice. Therefore, campuses should consider, for example, being in areas with good connectivity.

In addition, a finding important to note is that women who actively commute are more likely to report higher PA levels that those who use private transport. In addition, in the complementary analysis when compared active commuting vs public transport, men showed the same results, as well as being more likely to meet the MVPA recommendations. It seems possible that these results are due to the fact that Spanish women and men (66.4% and 55.6%, respectively) walked for the purpose of physical exercise (Martin Rodriguez et al., 2014). Although the records in this study are based on self-reporting, it appears that those students who were active commuters considered themselves to have higher PA levels than those who used either private or public transport, which is a good sign. Finally, we found a consistent and positive associations between active commuting and physical fitness. Previous results among university students (with fitness test and self-reported measurements) reported that students with greater cardiorespiratory fitness and muscular strength had lower morbidity and mortality (Chrismas et al., 2019), as well as well as healthy blood and lipid profiles (Fonseca-Camacho et al., 2014). Consequently, the associations of active commuting with the components of fitness in women (general physical condition and general health), suggest that women active commuters consider their bodies as operating at their optimal level, as mentioned in the literature (Bushman, 2019). In this line, it is important to highlight that cardiorespiratory fitness and muscular strength have been strongly investigated and are indicators of a healthy lifestyle, therefore, these findings could be valuable and useful for public health, where active commuting could be considered and included in future recommendations in the university population.

Following the methodological issue in Section I, it can be stated that self-reported questions, becomes a possible alternative in the absence of device measures, and is possible to estimate a quantitative measure of active commuting that allow researchers using a more sensitivity variable to improve the statistical power and have more accurate results. Examining whether potential self-reported measures might be highly associated with device-measured PA is of interest to improve the validity and quality assessment in future survey studies in this population. The self-reported commuting time and distance, and the calculated total EE presented associations with the device measured MVPA and sitting time in active commuting, and with light PA and sitting time in public and private transport. Active commuting is the mode that provides the highest EE per minute vs public and private transport, and the concepts of time and distance acquire sense because they may strongly determine choosing or not this active behaviour. These findings reinforce that, if commuting variables have been highly associated with device-measured PA, the available option of using self-report measures could be a useful measurement in university population.

Section III

Study 5. Patterns and Correlates

In accordance with the aims of this study, we identified three groups characterised as follows: Cluster 1: less sleep duration, skipping breakfast, low vigorous and moderate PA, and medium sitting time; Cluster 2: medium sleep duration, daily breakfast, medium vigorous and moderate PA, less sitting time, and motorised transport; and Cluster 3: more sleep duration, daily breakfast, high vigorous and moderate PA, more sitting time, and active commuting.

It has been argued that lifestyle behaviours are influenced between themselves (Anderson et al., 2022). There is evidence in adolescent (Miguel Angel et al., 2022) as well adult (Anderson et al., 2022) populations that at some point, lifestyle behaviours cluster together, meaning that individuals who engage in a particular lifestyle behaviour tend to adopt other similar behaviours (e.g., healthy habits tend to cluster with more healthy habits). For example, in this study, there is a trend towards lifestyle behaviour patterns in Clusters 2 and 3. First, it should be noted that students in Clusters 2 and 3 ate breakfast daily, in contrast to those in Cluster 1, who skipped breakfast. Previous studies have pointed to the importance of this behaviour and how skipping it could be a significant mental and physical health risk in the university population, with a tendency towards increased anxiety and depression (Chang et al., 2021), as well as overweight/obesity (Yamamoto et al., 2021). Second, a behaviour presented in Clusters 2 and 3 is related to higher PA levels compared to lower PA reported in Cluster 1. As previously stated (Kotarska et al., 2021; Krzepota et al., 2015; Vankim & Nelson, 2013), this could have important implications for the physical, social, and mental health outcomes of university students. In addition, students in Cluster 3 reported using active commuting to university, which makes sense that this is the Cluster with the highest PA levels (as associated in previous Sections), although at the same time, on the contrary, it has a longer sitting time. Indeed, in the case of sleep duration and sitting time, all three clusters are at risk according to the established thresholds. Restricted sleep duration recommended for young adults and adults (National Sleep Foundation, 2020) and high sitting time, such as more than 6 hours of total daily sitting time (Patterson et al., 2018) increase the risk of mental disorders and mortality, respectively. As described in previous studies, clustering is complex (Leech et al., 2014; López-Gil et al., 2020), having a trade-off between variables. According to different changes in the class routines in university, sleep disorders or the time students spend sitting down could be considered important behaviours to be taken into account. For instance, a current systematic review and meta-analysis related to sedentary behaviours showed that breaking up sitting time could be the goal of universities to reduce the amount of time university students spend sitting, along with PA promotion programmes (Castro et al., 2020). Therefore, knowing that university is a period of change and vulnerability, educational programmes that promote healthy lifestyle behaviours in more areas could be necessary.

The different lifestyle behaviours mentioned above could be important predictors of health in a population. In fact, according to the findings of this study, the combination of lifestyle behaviours in Clusters 2 and 3 showed significant odds of reporting high cardiorespiratory fitness, as well as muscular strength (significant only in Cluster 2). The components of fitness that are markers of health. In this line, a previous study in Colombia showed that university students with higher self-reported cardiorespiratory fitness and muscular strength (assessed by IFIS) had a lower prevalence of metabolic syndrome and its components, such as central obesity, blood pressure, triglycerides, and cholesterol level (Fonseca-Camacho et al., 2014). Although self-reporting was used in the same Colombian study, a previous study conducted in Spain on a university population showed that both self-reported and measured physical fitness (by IFIS vs the 20-m shuttle run test and handgrip test for cardiorespiratory fitness and muscular strength) were consistent predictors of adiposity and metabolic syndrome indicators (Ortega et al., 2013). Thus, the findings of the current study in relation to physical fitness provide a target for health professionals and contribute in several ways to our initial understanding of the different lifestyle behaviours related to sleep duration, breakfast status, activity intensity levels, and mode of commuting in university students. An important point to note of this is that each of the lifestyle behaviours considered in this study can be acquired and modified in the university period, whether to their benefit or not. In addition, this lifestyle behaviours can be prolonged throughout adulthood, which is the longest stage of life. Therefore, orientation and education on these topics should be considered in university formation for a healthier adult population.

Study 6. Patterns and Correlates

The main findings in the present study were that women students, from both countries, displayed larger barriers to active commuting to university compared to men students, and Chilean students reported high environmental/safety barriers and Spanish students reported high planning/psychosocial barriers. Moreover, the planning/psychosocial barriers were the most associated with private transport in all university students (men and women, in both countries). These findings suggest that the barriers to active commuting to university are influenced by gender and the country context of the students.

Firstly, Chilean women perceived more barriers to active commuting to university than Chilean men, while Spanish men and women perceived similar barriers. For Chilean women, the election of the mode of commuting could be determined by the security that implies (Ministry of Transport and Telecommunications, 2018). Indeed, a study conducted in Latin America indicated that the mode of commuting and women may affect each other, as well as gender diversity, by being highly exposed to experiencing harassment in commuting environments (Jirón & Singh, 2017). Secondly, Chilean students reported high environmental/safety barriers and Spanish students reported high planning/psychosocial barriers. As discussed in Section I, this may be due to lack of or poor infrastructure or road safety conditions. On the contrary, Spain has a better infrastructure in relation to the use of active commuting than developing countries such as Chile. However, the best example of friendly environments for active commuting are the European countries, such as the Netherlands, Germany, Denmark and Sweden, with dedicated cycle and pedestrian paths, and a safer environment (Shephard, 2008). Likewise, an initiative of the European Union called the "Handshake project", which helps cities of all types become more liveable places by improving conditions for active commuting, has included Spain.

An interesting current situation to contain the spreading and prevent overburdening healthcare systems for the current global pandemic COVID-19, is that active commuting has been the most effective declared strategy (Villa-González et al., 2022), such it includes isolation (Gallo et al., 2020), and physical distancing (Di Renzo et al., 2020). In fact, the WHO expressed that whenever possible, consider walking or cycling as this provides physical distancing and at the same time helps meet the minimum requirements for daily PA (WHO, 2021). For this, several countries, such as England, United States, Perú, Colombia, Chile and Spain, have improved the implementation of road extensions and provision of new temporary use bike lanes to promote a safer, healthier and more sustainable urban mobility (Yohannessen et al., 2020). Therefore, it is presumably to confirm that after the total deconfinement by COVID-19 in which we live today, there may be changes in awareness of active commuting and its barriers.

Finally, considering the commuting patterns outlined above in Section I and II, we analysed the association between the modes of commuting and the perceived barriers to active commuting in the participants. Overall, the interesting result was that private transport was associated with more perceiving planning/psychosocial barriers, in both men and women from Chile and Spain, compared to those using active commuting. In this line, a study with university students in Sevilla (Spain) indicated that although there are more sustainable and less polluting ways of commuting (such as walking or cycling), and more economical commuting (such as public bus or metro/train), students are reluctant to use them due to the optimization of time or convenience (Lucas-García et al., 2015). Accordingly, it could be indicated that if the use of motorised transport is the only option (for instance, due to the commuting distance or the weather), a research review showed that without improvements in the quality attributes of public transport (e.g., service reliability, speed, and frequency) there is no customer satisfaction, and consequently, the use of private transport increases (Redman et al., 2013). As indicated above, this may be an important call for planners and urban services, where if the use of private transport wants to be reduced, the quality of public transport services must be optimal. If it is already known that there is an urgent need to reduce the use of private transport (Campos Ferreira et al., 2022) for more sustainable alternatives, such as active commuting together with public transport (Redman et al., 2013), mitigate existing psychosocial and planning barriers should be a key strategy. For the same reason, it is important to continue considering creating and improving infrastructures for active commuting and addressing vial education programmes from an early age to a university or work level.

Study 7. Patterns and Correlates

The last study in this Doctoral Thesis explores the built environment features around six university campuses associated with active commuting of university students from Chile and Spain and shows important findings: the built environment features of university campuses were heterogeneous regardless of whether they belong to the same university or country and, the built environment features of university campuses are associated with active commuting. The findings could be a starting point for considering important effects of the built environment around university campuses in both countries.

In line with the commuting patterns of the population studied in this Thesis, the stakeholders of the campuses considered in this study should focus their efforts on benefiting the travel behaviour of their students through activity-friendly environments, as well as consider different factors. For instance, in Chile, Campus UTFSM Casa Central has greater use of active commuting, and at the same time, it is the university with the shortest commuting distance. As indicated in Sections I and II, living in university residences are associated with the use of active commuting to the university due to the shorter distances involved, so this could be a priority, especially for the PUCV Curauma, and PUCV Sausalito campuses. Furthermore, in Cádiz, the Spanish province included in this study, university campuses are located far from urban centres (with motorised transport being the only option). Therefore, as stated above, increasing the expansion and extension of public transportation services to the campuses, could increase their use among the university population. This could be particularly useful for the UCA Puerto Real campus, understanding that, the use of public transport not only decreases car dependency, but also involves higher PA levels (Chan & Farber, 2020), which would benefit students.

Considering the daily interaction between university students and their campuses, the eight built environment features assessed in this study could provide an objective perspective on what needs to be improved on campuses to have a positive impact on the health of university students. Furthermore, providing an activity-friendly environment on campuses should go hand in hand with also providing a more activity-friendly environment in a wider radius for the community, looking into the activity friendliness in cities as well. However, and according to the heterogeneous results of the built environment features of university campuses, it is important to consider the homogenization of structures.

On one hand, in Chile, campus PUCV Curauma and campus PUCV Sausalito, which showed the lowest and highest values of built environment features, respectively, belong to the same institution, but have been built in different years (2004 vs 1966, respectively). On the other hand, campus UTFSM Casa Central (built in 1931), which has similar built environment features to the campus PUCV Sausalito, belongs to another institution. In the case of Spain, the situation is no different. The three campuses evaluated belong to the same institution, were built in different years, and have different values for the built environment features. This makes us reflect on how the institutions, or even the region or the country, have not had a similarity in building codes over time to have homogeneous constructions on its campuses. In fact, in Chile and Spain there are networks of national universities focused on promoting health (e.g., https://www.redcampussustentable.cl/ and https://www.unisaludables.es/es/), which affirms the importance of built environments at the university, which could influence important benefits for its students and/or community through active travel behaviours, but there are no guidelines on what the environments should look like.

In order to create activity-friendly environments, and in view that universities are destinations that have the potential to engage students in PA through active commuting (Cole et al., 2008), it is important to consider public policies that may stipulate goals concerning to the environment and the determinants for PA (Nau et al., 2023). Environmental planning guidelines would serve both for the improvement of existing campuses and for future campuses to be built in each country. For instance, according to the findings of this study, it is possible to identify that in both countries, campuses that are integrated in urban areas showed a high use of active commuting, in contrast to campuses that are close to peripheral areas or with more difficulties to access, since are located close to industrial areas and heavy infrastructure, which showed low use of active commuting. In this case, the built environment feature that is most important is the residential density near the campuses, which could be considered for future changes in the cities studied. The city of Hong Kong is a case in point, where changes to the built environment of university campuses had important and measurable positive effects on walking behaviours (Sun et al., 2014). The above-mentioned study, shows that changes in the residential density, land use-mix, and services density, increased the walking distances and the proportion of walking trips versus private transport, increasing the PA levels of university students. Therefore, having individual data on each feature of the built environment provides valuable information for future specific changes in the built environment around the campuses analysed as well as for possible public policies on this topic, with the intention of improving PA levels in the university population through the increased use of active commuting.

Based on data from 14 cities worldwide, Sallis JF and his colleagues (Sallis et al., 2016) indicated that combinations of environmental features generally explained more variation in PA than single variables, suggesting that a relatively comprehensive approach is needed to design activity-supportive neighbourhoods. Accordingly, to associate students' active commuting (as a behaviour involving PA) with the built environment around campuses (as their daily visiting study place), we formulated a composite score of the built environment features assessed for each university campus. The likelihood of students using active commuting to university vs. motorised transport was significantly higher on campuses with a greater composite score of the built environment features, except in the campus PUCV Sausalito.

Analysing the current findings of the campuses UTFSM Casa Central, UCA Algeciras and UCA Jerez, with those of other previous research in university students (Lu et al., 2022; Sisson et al., 2008; Sun et al., 2014), confirms that the built environment directly influences transport-related PA. In contrast, in the case of the campus PUCV Sausalito, it is somewhat surprising that, even though it presented a high composite score of the built environment features, there was no association with active commuting. It is possible that in this case, active commuting to university may be influenced by other barriers, such as long commuting distance involved (according to the calculated distance) or even, planning or psychosocial barriers (such as too hot, sweaty, or too much physical effort, as stated in Study 6, Session III). In this line, the campus PUCV Sausalito is located at the top of a hill, which despite not being very high (48 m) is very steep, triggering an important physical effort. This could explain why, despite having a more favourable environment for active commuting, students prefer to use motorised transport.

For future interventions to promote active travel behaviours in university population, it is important to consider the different factors that could have an influence, both external (such as the environment) and internal (personal).

Overall strengths and limitations

Some of the strengths of this International Doctoral Thesis must be recognised:

- One remarkable strength of this Thesis is that it provides new findings of commuting patterns to and from university in Chilean and Spanish students, contributing to our knowledge in the field of active commuting to university which could emphasise public improvements in higher education, and bring individual as well as environmental benefits through active commuting.
- The commuting patterns associated with the different variables used were separated by gender. By taking into account the gender perspective in relation to the mode of commuting to university, this Doctoral Thesis adds additional value because transport-related policies may have a different impact on women and men.
- In addition, a main strength of this study is the differentiation between public and private transport in five of the seven studies included in this Thesis, considering that most of the studies combine both modes as a unique mode, but, although both are motorised, they have important differences at both the individual and environmental levels.
- Another strength of this Thesis were the diversity of variables and lifestyle behaviours considered, which, as indicated above, can influence each other. Therefore, having a broader view of the behaviour of the university population could be useful for future educational projections and in the health field.
- To our knowledge, the studies that constitute this Doctoral Thesis have been pioneering in the variety of analyses conducted in relation to active commuting to university, providing new information in both countries and reinforces the limited studies on active commuting in this specific population.

It is necessary to also recognise some limitations of this International Doctoral Thesis:

- Six of the seven studies included in this Thesis used the self-reported questionnaire which restricts the potential accuracy of the observed relationships. For instance, PA levels, sitting time, and sleep duration may provide under or overestimated values and should be supported by studies using device-based measures, and the perceived environmental barriers can be cross-checked with objective assessments of the built environment.
- The commuting distance, which is a determinant for the use of active commuting, and which was a variable used as a confounding factor, may not be the actual route chosen by the students, as the shortest walking distance in the network was used. The support of devices such as GPS is necessary to identify the actual route.
- Despite being a large sample size, the number of participants included was not representative of all the Chilean and Spanish university students', therefore, our findings must not be extrapolated to the entire university population in Chile and Spain.
- Furthermore, although the data assessed for the built environment around university campuses are the first to be available for both countries, due to the fact that Chile and Spain are countries with a wide area, cannot be extrapolated to different regions or provinces, and limited generalizability of findings to other parts of Chile and Spain.

FUTURE RESEARCH DIRECTIONS AND TRANSFERENCE OF THIS DOCTORAL THESIS

Future Research Directions

Section I. The findings in this Section regarding the Chilean university population and the potential benefits of increasing the PA levels and physical fitness components using active commuting to university, or even public transport, compared to private transport, are encouraging. Obtaining self-reported commuting variables allowed us to estimate a higher EE in active commuting to university, followed by public and private transport. Future studies using device measures, such as physical fitness test, are needed to confirm the correlates found for the health of young adults. In addition, it is important to consider that future studies must be developed in the different areas of Chile, due to the wide geographical differences across the country. The evidence on the effects of interventions to promote the use of active commuting in the university population is still scarce and limited, so future studies based on interventions will be necessary. A great opportunity would be to carry out interventions in the universities studied in this Doctoral Thesis, based on possible promising findings in relation to the increase in PA and physical condition and considering the factors studied.

Section II. The findings regarding the active commuting to university in Spanish university population and its potential benefits for health, are promising as in Section I. Additionally, evidence on the effects of active commuting to university on device-measured PA levels and sitting time, supports the idea that active commuting to and from university could contribute significantly to the MVPA recommendations, which may result in important health benefits. Being the first studies in a university population in the study Province, these findings are important and should be taken as a possible foundation and motivation for future studies and/or intervention in the UCA. Nonetheless, it is important to consider that if the scope of these studies wants to be expanded the different factors associated in this Section may differ, as well as the context with other cities in Spain.

Section III. Considering that there are different behaviours (e.g., sleep duration, breakfast status, and activity intensity levels), barriers (e.g., environment/safety and planning/psychosocial), and features of the environment (e.g., built environment around campuses) that could influence the choice of active commuting to university, future studies or interventions in university population need to consider a comprehensive approach, which could be more effective in stimulating more active and sustainable transport, such as cycling or walking. If the different factors are considered separately, there could be significant gaps in future research, or possible interventions that do not last over time. Therefore, future research or interventions focused in improving behaviours, such as using a daily active mode of commuting to university, and project it in the long term during adult life (e.g., subsequently, active commuting to work), should consider all possible determinants, such as individual, social, community, and environmental factors (as well as political factors that were not considered in this Thesis). Finally, a practical future perspective is to gather more information on the built environments around campuses in order to consider the possibility of developing a guide of practical recommendations for campuses with an activity-friendly environment. This could have benefits for both the university community and the general population, as well as for the environment and planetary health.

Transference

Considering that a change of behaviour in the population requires not only a personal effort, it is necessary to consider the transfer of this International Doctoral Thesis, having a broader and more transversal vision of all the stakeholders to achieve this objective with greater success.

Educational. A pragmatic implication of this International Doctoral Thesis is the possibility of encouraging students to use active commuting as a daily necessity to get to and from university, related not only to individual health, but also seen from an environmental point of view. Future educational plans in universities, as well as lectures, seminars, subjects, etc., throughout the university period could be an easy, simple, inexpensive, and sustainable first step, with promising learnings for the future of these young adults in training, especially in the universities studied in Chile and Spain.

Infrastructure. An important possible action to increase the use of active commuting to university and to have the potential benefits discussed above, is the active commuting services and facilities that universities can provide, extending and incentivising students' motivation to be more active and sustainable. Although infrastructure changes may represent a significant potential financial investment, it is even more important to consider the role of universities in public health and the environment. Contributing to spaces conducive to encouraging walking and cycling will not only provide possible changes in annual EE for students, but also for the entire university community (e.g., staff or professors), as well as reducing air and noise pollution and traffic congestion, contributing to possible improvements to the environmental barriers to active commuting.

Public policies. Finally, and possibly the constant and most difficult challenge of research and science transferability, is that in order to make the above two points possible, governmental involvement is required to achieve structural and real changes in the travel behaviour of the university population in Chile and Spain. Future studies, interventions or projects that consider engaging with university populations should enable collective participation. Although there is no specific information on the effectiveness of specific policies to increase walking and cycling, it can be projected that, with this type of support, there could be increased awareness and sustainable change over time.

CONCLUSIONS

General Conclusion

The present International Doctoral Thesis opens another window in the research on active commuting and its health benefits, in this case, with respect to new and important knowledge of patterns and correlates in a university population from Chile and Spain.

The use of active commuting to university could contribute to the MVPA recommendations to obtain health benefits, but their use could be conditioned by different individual, social and environmental factors that should be considered. Furthermore, this Doctoral Thesis concludes that if there are factors that inhibit the use of active commuting to university and motorised transports must be used, it is recommended to use public transport, which has the potential to involve higher PA levels than private transport and could have a lower impact on the environment. However, the use of public transport may depend on the amenities offered.

Overall, the finding of this International Doctoral Thesis could be of interest for future studies focused on the health of the university population, as well as for future strategies in transport policies, if more active and sustainable commute, such as walking and cycling, are to be promoted.

Specific Conclusions

Section I

Study 1. Public transport was the main mode of commuting to and from university in Chilean students. The sociodemographic characteristics with the greatest influence on the choice of active commuting to university in Chilean students were type of university, type of residence, age, and SES. In addition, the commuting variables calculated (speed and EE), based in self-reported variables (time and distance), provided valuable estimative measurement information, however, this source of PA among university students needs to be further examined with device-based measurements of commuting variables.

Study 2. Women and men who actively commuted to university were more likely to meet the MVPA recommendations and to reported higher muscular strength compared to those who used a private transport. The findings of this study support that actions to promote active commuting to university could lead to an increase in PA as well as physical fitness.

Section II

Study 3. Private transport was the main mode of commuting to and from university in Spanish students. The sociodemographic characteristics with the greatest influence on the choice of active commuting to university in Spanish students were type of residence, SES and distance to university. Women who actively commuted to university were more likely to have a high vigorous PA level. In addition, men and women active commuters were more likely to reported higher muscular strength and cardiorespiratory fitness, respectively. This could suggest that active commuting could be an important contribution to the health of this population.

Study 4. Walking approximately 7 min per trip (to or from university) could contribute to 44% weekly of the MVPA recommendations to obtain health benefits in university populations, as it involves the highest levels of EE per min, followed by public and private transport. Active commuting to university could be a real opportunity to increase the total volume of PA and reduce the total volume of sitting time in university students.

Section III

Study 5. According to the three clusters of lifestyle behaviours found among university students, having behaviours that include sleep duration close to recommendations, daily breakfast, high PA intensity levels, less sitting time, and active commuting to university was significantly associated with reporting high cardiorespiratory fitness and/or muscular strength. This could be clinically relevant and have important implications for future practice oriented to the public health and adult population, as both components of physical fitness are powerful markers of health.

Study 6. Women students agreed more strongly with barriers to active commuting than men students, especially in Chile. The environment/safety barriers were associated with greater use of public and private transport in women and men in Chile, and in women in Spain. In addition, the planning/psychosocial barriers were most frequently associated with private transport in all university students (men and women, in both countries). This study suggests that the barriers to active commuting were different and may be influenced by gender and country context.

Study 7. In summary, students' travel behaviour differs according to the campus they attend. The campus PUCV Curauma in Chile and the campus UCA Puerto Real in Spain showed the lowest values of the built environment features assessed and reported low use of active commuting. The findings of this study suggest that the built environment around campuses may affect the travel behaviours of university students, which could have implications for the health of these young adults. However, there are more factors that may play an important role and should be taken into account. In order to ensure activity-friendly environments to stimulate the population, public policy needs to be involved.

CONCLUSIONES

Conclusión General

La presente Tesis Doctoral Internacional abre otra ventana en la investigación sobre los desplazamientos activos y sus beneficios para la salud, en este caso, respecto a nuevos e importantes conocimientos sobre patrones y correlatos en una población universitaria de Chile y España.

El uso de desplazamientos activos a la universidad podría contribuir a las recomendaciones de actividad física moderada a vigorosa para obtener beneficios para la salud, pero su uso puede estar condicionado por diferentes factores individuales, sociales y ambientales que hay que considerar. Además, esta Tesis Doctoral concluye que, si existen factores que inhiben el uso de desplazamientos activos a la universidad y hay que recurrir a transportes motorizados, se recomienda utilizar el transporte público, que tiene el potencial de implicar mayores niveles de actividad física que el transporte privado y podría tener un menor impacto sobre el medio ambiente. No obstante, el uso del transporte público puede depender de las comodidades que ofrezca.

En general, los hallazgos de esta Tesis Doctoral Internacional podrían ser de interés para futuros estudios centrados en la salud de la población universitaria, así como para futuras estrategias en políticas de transporte, si se quieren promover desplazamientos más activos y sostenibles, como caminar y andar en bicicleta.

Conclusiones Específicas

Sección I

Estudio 1. El transporte público fue el principal modo de desplazamiento hacia y desde la universidad en los y las estudiantes chilenos/as. Las características sociodemográficas con mayor influencia en la elección del desplazamiento activo a la universidad fueron el tipo de universidad, el tipo de residencia, la edad y el nivel socioeconómico. Además, las variables de desplazamiento calculadas (velocidad y gasto energético), basadas en variables auto informadas (tiempo y distancia), proporcionaron una valiosa información de medición estimativa, sin embargo, esta fuente de actividad física necesita ser examinada más a fondo en población universitaria con mediciones basadas en dispositivos.

Estudio 2. Las mujeres y los hombres que se desplazaban activamente a la universidad tenían más probabilidades de cumplir las recomendaciones de actividad física moderada a vigorosa y de presentar una mayor fuerza muscular en comparación con los que utilizaban un medio de transporte privado. Los hallazgos de este estudio apoyan que las acciones para promover el desplazamiento activo a la universidad podrían conducir a un aumento de la actividad física, así como de la condición física.

Sección II

Estudio 3. El transporte privado fue el principal modo de desplazamiento hacia y desde la universidad en los y las estudiantes españoles. Las características sociodemográficas con mayor influencia en la elección del desplazamiento activo a la universidad en los y las estudiantes españoles fueron el tipo de residencia, el nivel socioeconómico y la distancia a la universidad. Las mujeres que se desplazaban activamente a la universidad eran más propensas a tener un nivel más alto de actividad física vigorosa. Además, los hombres y las mujeres que se desplazaban activamente a la universidad tenían más probabilidades de presentar una mayor fuerza muscular y un mejor estado cardiorrespiratorio, respectivamente. Esto podría sugerir que los desplazamientos activos podrían contribuir de forma importante a la salud de esta población.

Estudio 4. Caminar aproximadamente 7 minutos por trayecto (hacia o desde la universidad) podría contribuir al 44% semanal de las recomendaciones de actividad física moderada a vigorosa para obtener beneficios para la salud en poblaciones universitarias, ya que implica los mayores niveles de gasto energético por minuto, seguido del transporte público y privado. El desplazamiento activo a la universidad podría ser una oportunidad real para aumentar el volumen total de actividad física y reducir el volumen total de tiempo sedente en los y las estudiantes universitarios/as.

Sección III

Estudio 5. De acuerdo con los tres grupos de comportamientos de estilo de vida encontrados entre los y las estudiantes universitarios/as, tener comportamientos que incluyen una duración del sueño cercana a las recomendaciones, desayuno diario, mayores niveles de intensidad de actividad física, menos tiempo sentado y desplazamientos activos a la universidad se asoció significativamente con reportar una alta condición física cardiorrespiratoria y/o fuerza muscular. Esto podría ser clínicamente relevante y tener importantes implicaciones para la práctica futura orientada a la salud pública y la población adulta, ya que ambos componentes de la condición física son potentes marcadores de salud.

Estudio 6. Las estudiantes mujeres se mostraron más de acuerdo con las barreras al desplazamiento activo que los hombres estudiantes, especialmente en Chile. Las barreras medioambientales/seguridad se asociaron con un mayor uso del transporte público y privado en mujeres y hombres en Chile, y en mujeres en España. Además, las barreras de planificación/psicosociales se asociaron más frecuentemente con el transporte privado en todos los y las estudiantes universitarios en ambos países. Este estudio sugiere que las barreras a los desplazamientos activos a la universidad fueron diferentes y pueden estar influidas por el género y el contexto del país.

Estudio 7. Como resumen, el modo de desplazamiento de los y las estudiantes difiere según el campus al que asisten. El campus PUCV Curauma de Chile y el campus UCA Puerto Real de España mostraron los valores más bajos de las características del entorno construido evaluadas e informaron un bajo uso de los desplazamientos activos. Los resultados de este estudio sugieren que el entorno construido alrededor de los campus puede afectar a los comportamientos de desplazamiento de los y las estudiantes universitarios/as, lo que podría tener implicaciones para la salud de estos jóvenes adultos/as. Sin embargo, hay más factores que pueden desempeñar un papel importante y que deberían tenerse en cuenta. Para garantizar entornos favorables a la actividad que estimulen a la población, es necesario que intervengan las políticas públicas.

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ANNEXES

I. Approval of the Ethics Committee of Pontificia Universidad Católica de Valparaíso.

PONTIFICIA UNIVERSIDAD CATÓLICA DE VALPARAÍSO

CERTIFICACION ETICA
Comité de Bioética
Pontificia Universidad Católica de Valparaíso

Valparaíso, Enero de 2017

De mi consideración, en mi condición de Presidente del Comité de Bioética de la Pontificia Universidad Católica de Valparaíso, me permito informarles que el Proyecto ***Estudio sobre desplazamiento activo y actividad física en estudiantes universitarios de Chile",*** cuyo investigador responsable es el Prof. **Fernando Rodríguez-Rodríguez**, ha sido evaluado por el Comité de Bioética que represento, considerándose que cumple los estándares éticos definidos en las normativas internas de nuestra Institución y en la Declaración de Bioética y Derechos Humanos del 2005 de la UNESCO.

De acuerdo a ello, se estima que el proyecto se enmarca en los principios de respeto a los derechos humanos, garantizándolos en todos los procedimientos, metodologías y procesos del proyecto, así como en el tratamiento de los datos obtenidos, por lo cual se le otorga la aprobación fundamentada, destacándose los siguientes antecedentes:

Objetivo de la investigación:
La investigación tiene los siguientes objetivos:
a) Determinar los patrones del modo de desplazamiento en estudiantes universitarios y su evolución respecto a la etapa del liceo/colegio.
b) Conocer características descriptivas del desplazamiento activo tales como el tiempo de desplazamiento o la distancia.
c) Indagar en las barreras del desplazamiento activo.
d) Conocer variables asociadas al desplazamiento activo como el ingreso socioeconómico, lugar de residencia, el nivel de actividad física, el nivel de condición física y calidad de vida, y variables antropométricas.

Metodología de trabajo y muestra a estudiar:
El estudio es de tipo transversal y retrospectivo, con una muestra de sujetos no probabilística (intencionada), con un análisis descriptivo y correlacional.

Se realizará un cuestionario específico para aplicar en las Universidades participantes. Este cuestionario tiene como objetivo tener un diagnóstico de los hábitos de desplazamiento activo y variables relacionadas de los universitarios chilenos. El cuestionario se volverá a aplicar para conocer la evolución de los patrones en el modo de desplazamiento.

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El cuestionario tendrá dos partes: uno de conducta sobre el modo de desplazamiento actual y otra parte retrospectiva, que busca determinar el cambio en el desplazamiento activo entre el colegio y el primer año de Universidad. Por lo tanto, los participantes tendrán como principal requisito de inclusión, estar cursando primer año

Las variables a medir en la investigación son las siguientes:

- Evaluación de la fuerza de prensión manual con Dinamometría manual.
- Peso y talla.
- Perímetro de cintura.

Idoneidad del equipo investigador:
El investigador responsable trabaja como docente en la Escuela de Educación Física. Cuenta con grado de Magister en Magister en Medicina y Ciencias del Deporte y Doctorado en Ciencias de la Actividad Física implicadas en el rendimiento físico del ser humano.

Calidad del proyecto:
El planteamiento del problema, los objetivos, el diseño metodológico, y los resultados esperados están claramente descritos.

Información que recibirán los sujetos participantes del estudio:
El proyecto adjunta el cuestionario y los consentimientos informados, cumpliendo con los contenidos adecuados para este.

Valor Social:
El proyecto pretende aportar a la salud de estudiantes universitarios, determinado el modo de desplazamiento y actividad física en base a indicadores de salud. Además, determinara cómo el desplazamiento activo (caminando o en bicicleta) se presenta como una oportunidad para que las instituciones de educación superior implementen estrategias atractivas y sustentables, contribuyendo a la condición física y a la problemática de salud que presenta nuestro país producto de la inactividad física.

Validez Científica:
El diseño metodológico resulta apropiado para cumplir con los objetivos de investigación propuestos.

Selección equitativa de los sujetos:
Señala que todos los pacientes tendrán la oportunidad de participar en la investigación, si así lo desean y cumplen con los criterios de inclusión-exclusión.

Proporción Favorable Riesgo/Beneficio:
La participación en este estudio no implica ningún riesgo, daño físico o psicológico, y se tomarán todas las medidas que sean necesarias para garantizar la salud e integridad física y psíquica de quienes participen del estudio.

Respeto a los participantes inscritos:
El proyecto contempla, tanto la posibilidad de los sujetos de negarse a participar del estudio, como el compromiso de informar acerca de los resultados de la evaluación según se solicite.

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Los objetivos, metodología e instrumentos de la investigación, y las cartas de consentimiento informado se ciñen satisfactoriamente a las exigencias bioéticas habituales prescritas para este tipo de investigaciones, garantizando: la cooperación libre y voluntaria de los participantes, la total cobertura de costos, la integridad de los participantes y la confidencialidad de los datos recopilados.

Los Miembros del Comité de Bioética corresponden a:

Dietrich Lorenz	Teólogo y Filósofo	Vice-Gran Canciller	PUCV
Joel Saavedra	Físico	Vicerrector y Profesor	PUCV
Fernando Torres Pérez	Biólogo	Director de Investigación y Profesor	PUCV
Rodrigo Pascual	Kinesiólogo	Profesor	PUCV
Gloria Contreras	Profesora de Matemáticas y Física	Profesor	PUCV
Eugenia Colomer	Licenciada en Ciencias Religiosas y Magíster en Filosofía	Profesora	PUCV
Camila Zamora	Ingeniero Comercial	Coordinadora de Investigación	PUCV

Los documentos presentados por el investigador, que fueron revisados por el Comité de Bioética para la elaboración del presente certificado:

1. Formulario final del proyecto postulado (Versión Oficial)
2. Cartas de Consentimiento Informado
3. Ficha de antecedentes Ético/Bioéticos PUCV
4. Currículum del Investigador Responsable

En base a lo anteriormente expuesto, el Comité de Bioética de la Pontificia Universidad Católica de Valparaíso ha concluido la aprobación ética fundamentada del Proyecto. Por último, el Investigador Responsable se ha comprometido a que, al finalizar el estudio, informará al Comité de los resultados de este.

Le saluda cordialmente,

PONTIFICIA UNIVERSIDAD CATÓLICA DE VALPARAÍSO VICE G. CANCILLER

DIETRICH LORENZ DAIBER
Presidente Comité de Bioética
Pontificia Universidad Católica de Valparaíso

II. Approval of the Ethics Committee for Non-Biomedical Experimentation and evaluation of experimentation with Genetically Modified Organisms at the University of Cádiz.

UCA Universidad de Cádiz

Félix A. Ruiz
Profesor Titular / Facultad de Medicina

Vicerrectorado de Política Científica y Tecnológica
Centro de Transferencia Empresarial "El Olivillo"
Avda. Duque de Nájera, 12
11002 Cádiz

Comité de Ética de Experimentación No Biomédica y de evaluación de experimentación con Organismos Modificados Genéticamente.

INFORME SOBRE EL PROYECTO TITULADO:
"Diagnóstico del patrón de desplazamiento y actividad física de estudiantes, PDI y PAS de la Universidad de Cádiz: Estudio UCActive."

Investigador principal: Daniel Camiletti Moirón

Ref. 004/2021

- En general la Comisión de Bioética no acepta a evaluación proyectos ya realizados, salvo en casos concretos muy bien justificados. Por tanto, la evaluación del proyecto enviado se realizó de manera excepcional tras su correcta justificación por parte del Investigador Principal.
- Se trata de un estudio cuyo objetivo principal es conocer actividad física y sus desplazamientos de estudiantes y personal universitario utilizando encuestas.
- Durante la evaluación del proyecto se solicitaron aclaraciones, relacionadas con la protección de datos personales y los métodos de cumplimentación de cuestionarios. Éstas fueron contestadas de manera satisfactoria por el Investigador principal.
- No se identificaron elementos que requieran de una revisión mayor por parte de la comisión.

Por todo ello, **INFORMO**:
Que desde nuestro el punto de vista, el proyecto es viable desde el punto de vista ético.

En Cádiz, a 17 de julio de 2021

RUIZ RODRIGUEZ FELIX ALEJANDRO - 77175776N
Firmado digitalmente por RUIZ RODRIGUEZ FELIX ALEJANDRO - 77175776N
Fecha: 2021.07.17 11:22:04 +02'00'

Félix A. Ruiz
Secretario Sección CEENB-OMGs* del Comité de Bioética de la Universidad de Cádiz

** CEENB-OMGs: Comité de Ética de Experimentación No Biomédica y de evaluación de experimentación con Organismos Modificados Genéticamente.*

III. Questionnaire.

PONTIFICIA UNIVERSIDAD CATÓLICA DE VALPARAÍSO

IRyS Investigación en Rendimiento Físico y Salud

CUESTIONARIO SOBRE MODO DE DESPLAZAMIENTO Y ACTIVIDAD FÍSICA EN UNIVERSITARIOS

El siguiente cuestionario pretende recoger información y opiniones acerca de su información personal, modo de desplazamiento, nivel de actividad física y condición física.
A la hora de completar este cuestionario, **marque** con una **X** la respuesta que desee contestar y **escriba** el dato que se le pide en aquellas preguntas sin opciones de respuesta. **Por favor, lea despacio las preguntas, entiéndalas y conteste con sinceridad a todas y cada una de ellas.**

1. INFORMACIÓN PERSONAL Fecha de hoy: ____ / ____ / _______

1.1 Nombre y apellidos: ____ **1.2** Sexo: Hombre ☐ Mujer ☐

1.3 Fecha de nacimiento: ____/_____/_______

1.4 Carrera: ____

1.5 Año de ingreso en esta Carrera: ____________ **1.6** Año de ingreso en la Universidad: ____________

1.7 Dirección donde reside como estudiante **(POR FAVOR SEA PRECISO/A)**:

__________________ Ciudad ____________________ Sector/Población ______________________________ Calle __________ Número

1.8 Distancia desde donde reside como estudiante a la universidad: < 2 km ☐ 2-5 km ☐ > 5 km ☐

1.9 El área donde reside como estudiante es: Urbano ☐ Rural ☐

1.10 Donde reside como estudiante, ¿vives con familia?: Sí ☐ No ☐

1.11 Indique los bienes de su grupo y casa familiar:

¿Tiene algún vehículo motorizado de 4 ruedas? No ☐ Sí, uno ☐ Sí, dos o más ☐

Si respondió **Sí** en la pregunta anterior, indique si el/los vehiculos de su hogar son de su uso personal. Sí ☐ No ☐

¿Cuantos computadores (fijos y portatiles) hay en su casa?: Ninguno ☐ Uno ☐ Dos ☐ Más de dos ☐

¿Tiene su propia habitación?: Sí ☐ No ☐ ¿Hay acceso a internet en casa?: Sí ☐ No ☐

1.13 Horas de sueño promedio por noche (lunes-viernes): ____________

1.14 ¿Desayunas habitualmente?: Sí ☐ No ☐

2. MODO DE DESPLAZAMIENTO Y BARRERAS

2.1 En su último año de enseñanza media, ¿como iba desde su hogar al liceo/colegio? (Marque sólo una opción).

Caminando ☐ Bicicleta ☐ Automóvil ☐ Moto ☐ Autobús ☐ Tren/metro ☐ Otro: ____________

2.2 En su último año de enseñanza media ¿cuánto tiempo (minutos), se demoraba en desplazarse desde su hogar al liceo/colegio?

____

2.3 En su último año de enseñanza media, ¿cuánta distancia (km.) debía recorrer desde su hogar al liceo/colegio?

____

2.4 En su último año de enseñanza media, ¿como volvía desde su liceo/colegio a su hogar? (Marque una opción).

Caminando ☐ Bicicleta ☐ Automóvil ☐ Moto ☐ Autobús ☐ Tren/metro ☐ Otro: ____________

2.5 En su último año de enseñanza media ¿cuánto tiempo (minutos), se demoraba en desplazarse desde su liceo/colegio hasta su hogar?

____

2.6 En su último año de enseñanza media, ¿cuánta distancia (km.) debía recorrer desde su liceo/colegio hasta su hogar?

____

2.7 ¿Cómo va habitualmente de su hogar a la universidad? (Marque sólo una opción).

Caminando ☐ Bicicleta ☐ Automóvil ☐ Moto ☐ Autobús ☐ Tren/metro ☐ Otro: ____________

¿Por qué se desplaza de esta forma? ____

2.8 ¿Cuánto tiempo (minutos), se demora en desplazarse desde su hogar hasta su universidad?

____

2.9 ¿Cuánta distancia (km.) debe recorrer desde su hogar hasta su universidad?

____

2.10 ¿Cómo vuelve habitualmente de la universidad a su hogar? (Marque sólo una opción).

Caminando ☐ Bicicleta ☐ Automóvil ☐ Moto ☐ Autobús ☐ Tren/metro ☐ Otro: ____________

¿Por qué se desplaza de esta forma? ____

2.11 ¿Cuánto tiempo (minutos), se demora en desplazarse desde su universidad hasta su hogar?

____

2.12 ¿Cuánta distancia (km.) debe recorrer desde su universidad hasta su hogar?

____

2.13 ¿Cómo fue de su hogar a la universidad la semana pasada? Indique, donde corresponda, el tiempo en minutos que dedicó a ese desplazamiento (puede indicar más de una opción por cada día).
Indique también los minutos totales por semana al final.

	LUN	MART	MIERC	JUEV	VIER	Min. Totales
Caminando						
Bicicleta						
Automóvil						
Moto						
Autobús						
Tren/metro						
Otro: ________						

2.14 ¿Cómo volvió de la universidad a su hogar la semana pasada? Indique, donde corresponda, el tiempo en minutos que dedica a ese desplazamiento (puede indicar más de una opción por cada día).
Indique también los minutos totales por semana al final.

	LUN	MART	MIERC	JUEV	VIER	Min. Totales
Caminando						
Bicicleta						
Automóvil						
Moto						
Autobús						
Tren/metro						
Otro: ________						

2.15 En la siguiente tabla se muestran una serie de **razones o barreras que justificarían por qué algunos universitarios no se desplazan andando o en bicicleta a la universidad** como medio de transporte principal.
Señale el nivel de desacuerdo o acuerdo (1 a 4) que tiene con cada una de ellas, **rodeando** con un círculo la alternativa elegida.

		Totalmente en desacuerdo	Algo en desacuerdo	Algo de acuerdo	Totalmente de acuerdo
a	No hay ciclovías.	1	2	3	4
b	Las ciclovías están ocupadas por personas que van caminando.	1	2	3	4
c	Hay demasiado tráfico a lo largo de la ruta.	1	2	3	4
d	Hay uno o más cruces peligrosos a lo largo del camino.	1	2	3	4
e	Paso demasiado calor y sudo cuando voy caminando o en bicicleta.	1	2	3	4
f	Voy demasiado cargado con cosas como para ir caminando o en bicicleta.	1	2	3	4
g	Es más fácil desplazarme con mi propio transporte: auto o motocicleta.	1	2	3	4
h	Caminar o ir en bicicleta implica demasiada planificación previa.	1	2	3	4
i	Es necesario demasiado tiempo.	1	2	3	4
j	Es necesario demasiado esfuerzo físico.	1	2	3	4
k	Necesito el auto o la motocicleta por temas de trabajo.	1	2	3	4
l	Caminar o ir en bicicleta es inseguro debido a la delincuencia.	1	2	3	4
m	No hay sitios donde dejar la bicicleta con seguridad.	1	2	3	4
n	Las calles son peligrosas debido a los autos.	1	2	3	4

3. CUESTIONARIO DE ACTIVIDAD FÍSICA (IPAQ)

Las preguntas a continuación se referirán acerca del tiempo que usted utilizó siendo físicamente activo(a) en los últimos 7 días. Por favor responda cada pregunta aún si usted no se considera una persona activa. Piense en aquellas actividades que usted hace como parte del estudio, trabajo, si es así, y en la casa, para ir de un sitio a otro, y en su tiempo libre de descanso, ejercicio o deporte.

3.1 Piense en todas las actividades INTENSAS que usted realizó en los últimos 7 días. Las actividades físicas intensas son aquellas que implican un esfuerzo físico intenso y que le hacen respirar mucho más intensamente que lo normal. Piense *sólo* en aquellas actividades físicas que realizó durante por lo menos 10 MINUTOS continuos.

a. Durante los últimos 7 días, ¿en cuántos realizó actividades físicas INTENSAS, tales como levantar pesos pesados, cavar, deportes y juegos competitivos, hacer ejercicios aeróbicos de alta demanda energética o andar rápido en bicicleta?

______ Días por semana

b. Habitualmente, ¿cuánto tiempo en total dedicó a una actividad física INTENSA en uno de esos días?

____ Minutos por día

3.2 Piense acerca de todas aquellas actividades MODERADAS que usted realizó en los últimos 7 días. Actividades moderadas son aquellas que requieren un esfuerzo físico moderado y le hace respirar algo más fuerte que lo normal.

a. Durante los últimos 7 días, ¿en cuántos días hizo actividades físicas MODERADAS como transportar pesos livianos, andar en bicicleta a velocidad regular o bailar? No incluya caminar.

______ Días por semana

b. Habitualmente, ¿Cuánto tiempo en total dedicó a una actividad física moderada en uno de esos días?

_____ Minutos por día

3.3 Piense en el tiempo que usted dedicó a CAMINAR en los últimos 7 días. Esto incluye caminar en el trabajo o en la casa, para trasladarse de un lugar a otro, o cualquier otra caminata que usted podría hacer solamente para la recreación, el deporte, el ejercicio o el ocio.

a. Durante los últimos 7 días, ¿En cuántos caminó por lo menos 10 minutos seguidos?

______ Días por semana

b. Habitualmente, ¿cuánto tiempo en total dedicó a caminar en uno de esos días?

______ Minutos por día

3.4 Piense acerca del tiempo que pasó usted SENTADO durante los últimos 7 días. Esto incluye el tiempo dedicado al trabajo, en la casa, en una clase, y durante el tiempo libre. Puede incluir el tiempo que pasó sentado ante un escritorio, visitando amigos, leyendo, viajando en ómnibus, o sentado o recostado mirando la televisión.

a. Durante los últimos 7 días ¿cuánto tiempo pasó sentado durante un día?

____ Minutos por día

4. CUESTIONARIO DE AUTOEVALUACIÓN DE LA CONDICIÓN FÍSICA Y CALIDAD DE VIDA

Por favor, es muy importante que conteste a las siguientes preguntas usted solo, sin tener en cuenta las respuestas de otras personas. Sus respuestas sólo son útiles para el progreso de la ciencia. Por favor, conteste todas las preguntas con sinceridad y no las deje en blanco. Y aún más importante, sea sincero. Gracias por su cooperación con la ciencia.

Piense sobre su nivel de condición física (comparado con sus amigos/as) y elija la opción más adecuada para cada pregunta.

4.1 Mi condición física general es:

Muy mala ☐ Mala ☐ Aceptable ☐ Buena ☐ Muy buena ☐

4.2 Mi condición física cardio-respiratoria (capacidad para hacer ejercicio, por ejemplo, correr durante mucho tiempo) es:

Muy mala ☐ Mala ☐ Aceptable ☐ Buena ☐ Muy buena ☐

4.3 Mi fuerza muscular es:

Muy mala ☐ Mala ☐ Aceptable ☐ Buena ☐ Muy buena ☐

4.4 Mi velocidad / agilidad es:

Muy mala ☐ Mala ☐ Aceptable ☐ Buena ☐ Muy buena ☐

4.5 Mi flexibilidad es:

Muy mala ☐ Mala ☐ Aceptable ☐ Buena ☐ Muy buena ☐

4.6 En general, usted diría que su salud es:

Mala ☐ Regular ☐ Buena ☐ Muy buena ☐ Excelente ☐

¿Tiene alguna sugerencia/observación sobre el cuestionario? ¡Cuéntenosla!

Aquí termina su cuestionario.

MUCHAS GRACIAS POR SU ATENCIÓN Y DEDICACIÓN

IV. Example of Calculations of both used based on the code of the Compendium of Physical Activities for Adults, according to the classified mode of commuting to university.

	Classified mode of commuting to university		
	Active	Public	Private
Code of the CPAA for EE p/m			
17151	2.0 METs (less than 3.0 km/hr)	(1.3 METs × time to commuting) + (7.5⁎ × 2.5 METs⁑) / time to commuting	1.3 METs
171152	2.8 METs (3.0 to 3.9 km/hr)		
17170)	3.0 METs (4.0 to 4.49 km/hr)		
17170 + 17200	3.65 METs (4.5 to 5.49 km/hr)		
17200	4.3 METs (5.5 to 6.49 km/hr)		
17220	5 METs (6.5 to 6.9 km/hr		
17230	7 METs (7 to 8.49 km/hr)		
17231	8.3 METs (≥ 8.5 km/hr)		
Calculated			
Total EE	(METs according to EE p/m × time to commuting)	(1.3 METs × time to commuting) + (7.5⁎ × 2.5 METs⁑)	(1.3 METs × time to commuting)

Notes: (CPAA) Compendium of Physical Activities for Adults; (EE) Energy expenditure; (p/m) per min; (PA) physical activity (km/hr) kilometres/hours; (⁎) minutes added per trip; (⁑) code 17161 considering walking to the stations and stops.

V. **Additional analysis. Associations between mode of commuting with physical activity, sitting time, and physical fitness of participants by gender.**

	Mode of commuting to university*			
	Men		Women	
	Active	Public	Active	Public
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Physical Activity and Sitting time				
PA Levels				
Light	Ref.	Ref.	Ref.	Ref.
Moderate	**3.20 (1.33, 7.69)**	**2.40 (1.04, 5.56)**	1.27 (0.63, 2.58)	0.97 (0.52, 1.73)
Vigorous	**2.67 (1.18, 6.04)**	**2.58 (1.20, 5.53)**	**2.72 (1.10, 6.74)**	2.02 (0.90, 4.51)
MVPA recommendations				
Not meeting	Ref.	Ref.	Ref.	Ref.
Meeting	**2.29 (1.16, 4.54)**	**2.07 (1.08, 3,96)**	**2.07 (1.02, 4.18)**	1.58 (0.85, 2.93)
Total physical activity	1.00 (0.99, 1.01)	1.00 (0.99, 1.00)	**1.00 (1.00, 1.03)**	1.48 (0.98, 2.23)
Sitting time	0.61 (0.32, 1.13)	0.746 (0.41, 1.33)	**0.29 (0.15, 0.54)**	**0.43 (0.25, 0.73)**
Fitness				
General Physical Condition	1.17 (0.85, 1.62)	1.34 (0.98, 1.83)	0.81 (0.59, 1.12)	0.85 (0.65, 1.12)
Cardio-respiratory Fitness	1.23 (0.92, 1.66)	1.32 (0.99, 1.75)	0.84 (0.63, 1.12)	0.89 (0.70, 1.15)
Muscular Strength	**1.91 (1.36, 2.69)**	**1.77 (1.28, 2.46)**	**1.39 (1.02, 1.88)**	1.28 (0.99, 1.66)
Speed and Agility	1.30 (0.94, 1.79)	**1.41 (1.04, 1.92)**	1.13 (0.83, 1.55)	1.08 (0.82, 1.41)
Flexibility	1.17 (0.88, 1.55)	1.29 (0.98, 1.68)	**1.33 (1.00, 1.75)**	**1.34 (1.06, 1.70)**
General Health	1.31 (0.92, 1.86)	**1.51 (1.08, 2.12)**	0.99 (0.71, 1.39)	1.22 (0.92, 1.62)

Notes: analysis were adjusted for physical activity recommendations and Fitness self-reported (except in the analysis when that variable was the predictor variable). (OR) Odd Ratio; (95% CI) 95% Confidence Intervals; (Ref.) reference; (PA) Physical Activity; (MVPA) moderate to vigorous physical activity; (*) Private transport was established as reference; and (bold) significant association with $p<0.05$.