OULU 2020
D 1567

ACTA UNIVERSITATIS OULUENSIS

Eveliina Heikkala

CO-OCCURRENCE OF UNHEALTHY BEHAVIOURS AND PSYCHOSOCIAL PROBLEMS AMONG ADOLESCENTS, WITH SPECIAL REFERENCE TO LOW BACK AND MULTISITE MUSCULOSKELETAL PAINS DURING ADOLESCENCE AND LABOUR MARKET EXCLUSION IN EARLY ADULTHOOD

UNIVERSITY OF OULU GRADUATE SCHOOL;
UNIVERSITY OF OULU,
FACULTY OF MEDICINE;
MEDICAL RESEARCH CENTER OULU;
CENTER FOR LIFE COURSE HEALTH RESEARCH

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Academic dissertation to be presented with the assent of the Doctoral Training Committee of Health and Biosciences of the University of Oulu for public defence in Auditorium F202 of the Faculty of Medicine (Aapistie 5 B), on 8 May 2020, at 12 noon

UNIVERSITY OF OULU, OULU 2020

Acta Univ. Oul. D 1567, 2020

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ISBN 978-952-62-2575-3 (Paperback)
ISBN 978-952-62-2576-0 (PDF)

ISSN 0355-3221 (Printed)
ISSN 1796-2234 (Online)

Cover Design
Raimo Ahonen

PUNAMUSTA
TAMPERE 2020

Heikkala, Eveliina, Co-occurrence of unhealthy behaviours and psychosocial problems among adolescents, with special reference to low back and multisite musculoskeletal pains during adolescence and labour market exclusion in early adulthood.

University of Oulu Graduate School; University of Oulu, Faculty of Medicine; Medical Research Center Oulu; Center for Life Course Health Research

Acta Univ. Oul. D 1567, 2020

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Abstract

Unhealthy behaviours and psychosocial problems often coincide during adolescence. Previous literature has connected these factors separately to musculoskeletal (MS) pains and difficulties in labour market inclusion. However, little is known about the influence of co-occurring health-related behaviour patterns on MS pains and labour market exclusion.

This Northern Finland Birth Cohort 1986 study evaluated the co-occurrence of unhealthy behaviours and psychosocial problems among 15¬–16-year-old adolescents, and estimated the determinant value of co-occurring health-related behaviours in explaining low back pain (LBP) and recurrent multisite musculoskeletal pain (MMSP) between the ages 15 and 19. It also determined exclusion from the labour market during a five-year follow-up period between the ages of 25 and 29, and studied the stability of the unhealthy behaviours between the ages of 15 and 19 and the possible influence of MMSP on the relationships between co-occurring health-related patterns and difficulties in labour market inclusion. Information on health-related behaviours and MS pains were gathered via two questionnaires. The labour market data, including data on unemployment, employment and permanent work disability, were based on national registers. Latent class analysis (LCA) was utilized to study the accumulation of the health-related behaviours.

Psychosocial problems and unhealthy behaviours divided adolescents into four subgroups (clusters), in which unhealthy behaviours persisted between the ages of 15 and 19. Belonging to the *Psychosocial cluster*, in which the prevalence of smoking and physical activity were at a moderate/high level, was associated with LBP and recurrent MMSP among both genders, whereas belonging to the Psychosocial cluster and having several unhealthy behaviours (=*Multiple risk behaviours cluster*) was associated with LBP and recurrent MMSP among women. Belonging to the *Obese cluster* was also associated with LBP among women, whereas belonging to the *Sedentary cluster*, characterized by high physical inactivity and long sitting time levels, was associated with recurrent MMSP among men. Among men, belonging to any adverse cluster was associated with labour market exclusion. Among women, a similar relationship was found between the cluster with a number of health-related behaviour problems and labour market exclusion. MMSP played no role in the associations observed between the clusters and labour market outcomes.

An accumulation of adverse health-related behaviours seems to expose young people to MS pain during adolescence and to difficulties in labour market inclusion during early adulthood in the early stage of the working career. Evaluation of both unhealthy behaviours and psychosocial problems might help identify risk groups and provide opportunities to create targeted health promotion programmes for adolescents to support MS health and labour market inclusion.

Keywords: adolescent, co-occurrence, follow-up, health behaviour, labour market, low back pain, multisite pain, psychosocial problem

Heikkala, Eveliina, Nuoruuden epäedullisten elintapojen ja psykososiaalisten ongelmien yhteisesiintyvyyden vaikutus alaselkäkipuun ja monipaikkaiseen tuki- ja liikuntaelinkipuun nuoruudessa sekä työelämän ulkopuolelle jäämiseen varhaisaikuisuudessa.

Oulun yliopiston tutkijakoulu; Oulun yliopisto, Lääketieteellinen tiedekunta; Medical Research Center Oulu; Elinikäisen terveyden tutkimusyksikkö

Acta Univ. Oul. D 1567, 2020
Oulun yliopisto, PL 8000, 90014 Oulun yliopisto

Tiivistelmä

Nuorten epäedulliset elintavat ja psykososiaaliset ongelmat liittyvät usein toisiinsa. Aiemmat tutkimukset ovat yhdistäneet nämä tekijät nuoruuden ja varhaisaikuisuuden tuki- ja liikuntaelinkipuihin sekä työelämään kiinnittymisen vaikeuksiin, mutta niiden yhteisvaikutus tunnetaan puutteellisesti.

Tässä Pohjois-Suomen syntymäkohortti 1986:een pohjautuvassa tutkimuksessa selvitettiin 15–16-vuotiaiden nuorten psykososiaalisten ongelmien ja epäedullisten elintapojen yhteisesiintyvyyttä ja arvioitiin niiden yhteyttä alaselkäkipuun ja toistuvaan monipaikkaiseen kipuun kahden vuoden seurannassa sekä yhteyttä työelämään kiinnittymättömyyteen viiden vuoden seurantajaksolla 25–29 vuoden iässä. Lisäksi analysoitiin epäedullisten elintapojen pysyvyyttä 15–19 vuoden iässä sekä monipaikkaisen kivun mahdollista vaikutusta havaittuihin yhteyksiin kasautuneiden psykososiaalisten ongelmien ja epäedullisten elintapojen ja työelämään kiinnittymättömyyden välillä. Tiedot terveyteen liittyvistä tekijöistä ja tuki- ja liikuntaelinkivuista kerättiin kahden kyselyn avulla. Työelämäaineisto perustui kansallisiin rekistereihin. Latent Class Analysis-menetelmällä selvitettiin psykososiaalisten ongelmien ja epäedullisten elintapojen kasautumista.

Psykososiaalisten ongelmien ja epäedullisten elintapojen perusteella nuoret muodostivat neljä ryhmää, joissa epäedulliset elintavat säilyivät 15–19 vuoden iässä. Kuuluminen ryhmään, jossa korostui psykososiaalisten ongelmien lisäksi tupakointi ja fyysinen aktiivisuus sekä miehillä että naisilla, tai useat haitalliset tekijät naisilla, oli yhteydessä alaselkäkipuun ja toistuvaan monipaikkaiseen tuki- ja liikuntaelinkipuun. Lihavien naisten ryhmä yhdistyi alaselkäkipuun, kun taas ryhmä, jota kuvasi runsas istuminen ja fyysinen inaktiivisuus, yhdistyi toistuvaan monipaikkaiseen tuki- ja liikuntaelinkipuun miehillä. Kuuluminen mihin tahansa epäedulliseen ryhmään ennusti miehillä työelämän ulkopuolelle jäämistä. Naisilla samanlainen yhteys löydettiin moniongelmaisen ryhmän ja työelämän ulkopuolelle jäämisen välillä. Monipaikkainen kipu ei vaikuttanut ryhmien ja työelämävasteiden väliseen yhteyteen.

Epäedullisten terveyteen liittyvien tekijöiden kasautuminen altistaa nuoret tuki- ja liikuntaelinkivuille nuoruudessa sekä työelämään kiinnittymisen ongelmille varhaisaikuisuudessa työuran alkuvaiheessa. Elintapa- ja psykososiaalisten tekijöiden arviointi voi edesauttaa riskiryhmien tunnistamisessa ja luoda mahdollisuuksia aikaisempaa yksilöllisempään terveyden ja työelämään kiinnittymisen tukemiseen.

Asiasanat: alaselkäkipu, elintapa, monipaikkainen kipu, nuori, psykososiaalinen ongelma, seuranta, työelämä, yhteisesiintyvyys

To my family

Acknowledgements

This study was carried out in the Medical Research Center Oulu, University of Oulu and the Oulu University Hospital during 2012–2020.

The current dissertation has taken a long time to mature. I am grateful that I have managed to walk this journey with a number of wonderful people next to me. First and foremost, I want to thank my supervisors, Professor Jaro Karppinen, Docent Simo Taimela and Docent Markus Paananen. These men have taught me so much about conducting research and about the research world in general. I feel that I have grown from a little girl into a real researcher thanks to them.

The positivity and encouragement of my principal supervisor, Professor Jaro Karppinen, has always driven me to do my very best. His commitment to my project has been truly exceptional and I could not imagine a better principal supervisor for research work. Docent Taimela has provided valuable and critical feedback and new perspectives with respect to study design and research questions, always in the right places. He has not let me off easily and has always ensured that the quality of our publications is of a high level, for which I am sincerely grateful. Docent Paananen, who has been my closest supervisor, has given me important advice and provided support whenever needed – even when in a hurry or on holiday. He has taught me statistical analysis and always encouraged me to continue, regardless of tough adversities.

I am grateful to Paula Mikkonen, PhD, for writing the second original publication with me. I would also like to express my gratitude to Jouko Remes, MSc, who calculated the statistics for the first and second original publications; and Professor Juha Auvinen for revising the original publications and providing suggestions to improve the manuscripts. I am genuinely thankful to Professor Leena Ala-Mursula for her expertise and constructive help and support in the labour market-related issues in the fourth original publication. I also wish to warmly thank Docent Eero Kyllönen and Docent Minna Ruddock for their valuable advice, Eeva Vaaramo, MSc, for her help with labour market data, and Alice Lehtinen and Elina Karjalainen for language revision. I am grateful to my reviewers, Professor Urho Kujala and Professor Marja Mikkelsson, for their instructive and precise comments.

I also dearly thank all my friends and colleagues, especially Maria Hagnäs, PhD, and Heidi Varis for being interested in my research and supporting me. I am especially grateful to Senior Physician Outi Palmén for enabling me to take a short leave of absence to finish the last original publications and this thesis.

I owe my special thanks to my brother Aleksi and his family for always being there for me and bringing so much joy to my life. I wish to express my warmest thanks to my dearest parents, Tarja and Hannu, who have genuinely supported me since the day I was born. Their understanding and encouragement on this journey have been invaluable. Last but not least, my greatest thanks goes to my loving wife and best friend, Miia, who has supported me every day, provided me with the opportunity to finish this dissertation, and taught me so much about life. Without her, I would be a totally different person and this thesis might not exist today. Thank you.

Rovaniemi, October 2019 Eveliina Heikkala

Abbreviations

ADHD	Attention-deficit/hyperactivity disorder
AIC	Akaike Information Criterion
BIC	Bayesian Information Criterion
BMI	Body mass index
CI	Confidence interval
DP	Disability pension
ID	Identity
ILO	International Labour Office
LBP	Low back pain
LCA	Latent class analysis
LRT	Vuong-Lo-Mendell-Rubin likelihood ratio test
MMSP	Multisite musculoskeletal pain
MVPA	Moderate to vigorous leisure time PA
MS	Musculoskeletal
N	Number of participants
NEET	Not in employment, education or training
NFBC1986	Northern Finland Birth Cohort 1986
NPS	Number of pain sites
OBS	Oulu Back Study
OECD	Organisation for Economic Co-operation and Development
OR	Odds ratio
P	Statistical significance
PA	Physical activity
RR	Risk ratio
SES	Socioeconomic status
SPSS	Statistical package for the social sciences
SSABIC	Sample-size adjusted BIC
UK	United Kingdom
US(A)	United States (of America)
WHO	World Health Organization
WSP	Widespread pain
YSR	Youth Self-Report

List of original articles

The current thesis is based on the following articles, which are referred to in the text by Roman numerals from I to IV.

I Heikkala, E., Remes, J., Paananen, M., Taimela, S., Auvinen, J., & Karppinen, J. (2014). Accumulation of lifestyle and psychosocial problems and persistence of adverse lifestyle over two-year follow-up among Finnish adolescents. *BMC Public Health, 14*, 542.

II Mikkonen, P.*, Heikkala, E.*, Paananen, M., Remes, J., Taimela, S., Auvinen, J., & Karppinen, J. (2015). Accumulation of psychosocial and lifestyle factors and risk of low back pain in adolescence: A cohort study. *European Spine Journal, 25*, 635-642.

III Heikkala, E., Paananen, M., Taimela, S., Auvinen, J., & Karppinen, J. (2019). Associations of co-occurring psychosocial and lifestyle factors with multisite musculoskeletal pain during late adolescence – A birth cohort study. *European Journal of Pain, 23*, 1486-1496.

IV Heikkala, E., Ala-Mursula, L., Taimela, S., Paananen, M., Vaaramo, E., Auvinen, J., & Karppinen, J. (2019). Accumulated unhealthy behaviors and psychosocial problems in adolescence are associated with labor market exclusion in early adulthood – A Northern Finland Birth Cohort 1986 Study. Manuscript submitted for publication.

*These authors contributed equally to this work.

Contents

1 Introduction

Adolescence is a critical stage of life and challenges individuals in social, psychological and biological contexts. It is also the time when health behaviours and psychosocial well-being tend to emerge and become established. Most young people seem to manage well, and the global prevalence of smoking, for instance, has decreased over the last decades (GBD 2015 Tobacco Collaborators, 2017). However, a significant proportion of Western adolescents do not reach the recommended levels of sleep (Kann et al., 2016) and physical activity (PA) (Ekelund, Tomkinson, & Armstrong, 2011) and are overweight or obese (Ng et al., 2014). In addition, more young people suffer from internalizing problems today than earlier (Bor, Dean, Najman, & Hayatbakhsh, 2014).

Musculoskeletal (MS) pain problems are frequent and cause individual and communal disadvantages already during adolescence. Symptomatic adolescents often report lower quality of life (Paananen et al., 2011) and pain-associated disabilities (Hoftun, Romundstad, & Rygg, 2012), and have more psychological problems (Eckhoff, Straume, & Kvernmo, 2017a). Of MS pains, low back pain (LBP) is one of the most common single-site pains (Calvo-Muñoz, Gómez-Conesa, & Sánchez-Meca, 2013), and multisite musculoskeletal pain (MMSP) is the most detrimental form of pain (Hoftun, Romundstad, Zwart, & Rygg, 2011; Paananen et al., 2011). Adolescent MS pain disposes individuals to subsequent pain problems in adulthood (Junge, Wedderkopp, Boyle, & Kjaer, 2019).

One of the main goals during early adulthood is to obtain a job and to successfully make the transition from education to the labour market. According to international statistics, about one-sixth of European young people fail in this task and are unemployed or outside both education and labour markets (Eurofound, 2017; International Labour Office [ILO], 2017). Early hardships in working life can have long-term impacts on later labour market survival (Helgesson, Johansson, Nordqvist, Lundberg, & Vingård 2013) and shorten careers from the initial phase of working life, posing a challenge to ageing Western societies. Young people who are not integrated into the labour market comprise a difficult target group for effective preventive interventions (Mawn et al., 2017). This emphasizes the importance of preventive research.

Research literature has acknowledged associations between unhealthy behaviours and psychosocial problems and recognized them as modifiable determinants of MS pain and different labour market outcomes (e.g. Chaput et al., 2016, Huguet et al., 2016, Rodwell et al., 2018). However, we do not know how

unhealthy behaviours and psychosocial problems behave when evaluated simultaneously or whether significant health-related risk groups exist in relation to later pain and societal problems. Identifying potential risk groups might provide new perspectives for understanding the multifactorial aetiology of MS pains and labour market outcomes and for creating more tailored preventive programmes.

The primary aim of the current study was to explore the co-occurrence of psychosocial (internalizing and externalizing) problems and health behaviours (smoking, sedentary behaviour, sleeping time, PA level, and overweight/obesity) among 15- to 16-year-old Finnish adolescents. Secondly, the study aimed to evaluate whether unhealthy behaviours persisted within the formed health-related subgroups. Thirdly, it analysed whether co-occurring patterns of health-related behaviours played a role in explaining a) LBP, b) recurrent MMSP and c) labour market exclusion. Lastly, it examined whether MMSP influenced the possible relations between the health-related subgroups and the studied labour market outcomes.

An underlying hypothesis was that significant subgroups of health-related behaviours would be found and that these subgroups, in which psychosocial problems are highlighted, would be at an increased risk of subsequent MS problems and labour market exclusion. Unhealthy behaviours were expected to persist and MMSP to play a role in explaining the possible relationships between baseline subgroups and labour market outcomes.

2 Review of the literature

2.1 From adolescence to early adulthood

2.1.1 Concept of health

Ancient Greek philosophers recognized the concept of health as the internal and external harmony of physical and mental dimensions, and disharmony as the natural cause of diseases. In 1948, the World Health Organization (WHO) published a definition on which the modern understanding of health is now based. WHO claimed that health was 'a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity'. Accordingly, 'health' is a balance of all the dimensions into which the concept is divided, including mental, physical and social categories (Fig. 1).

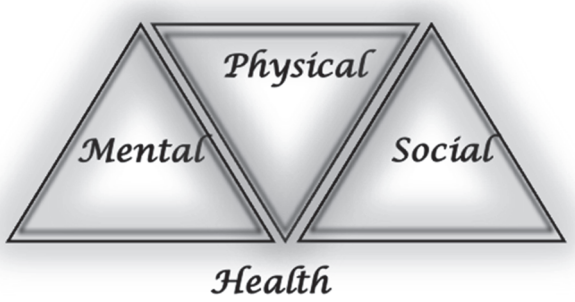

Fig. 1. Concept of health (WHO).

2.1.2 Adolescence

According to WHO, adolescence is the time period that covers the years between the ages of 10 and 19. From the growth and development perspective, adolescence has been characterized as starting from the onset of puberty and ending at certain social endpoints such as employment, consummation of education and marriage. However, the definition of the completion of this phase is no longer so clear cut: for example, today's adolescents take longer to reach the mentioned endpoints than those of some decades ago (Sawyer et al., 2012). Consequently, it has been

proposed that adolescence should be extended to the age of 24 (Sawyer, Azzopardi, Wickremarathne, & Patton, 2018). 'Youth', in turn, has been defined by the United Nations as a period between the ages of 15 and 24. Together, adolescence and youth comprise a group of 10–24-year-olds, referred to as 'young people'.

Adolescence challenges individuals in social and psychological contexts. Young people need to construct their identities and develop a picture of themselves in their social lives. Social interactions tend to convert from child-parent relationships to peer relationships, and social groups grow and gain more complex characteristics (Spear, 2000). Responsibilities related to decisions, actions and general autonomy increase gradually, and new skills and levels of knowledge are acquired to enable a successful transition into adulthood (Dahl, Allen, Wilbrecht, & Suleiman, 2018). In contrast to earlier times, today's adolescent development is also under the influence of not only opportunities but also risks related to the 'digital world' (Dahl et al., 2018).

During the adolescent years, enormous biological changes occur in pubertal status and the brain's structure and function. For instance, the structure of the amygdala and hippocampus begin to grow (Caballero, Granberg, & Tseng, 2016), and enhanced activity of the ventral striatum, coupled with low recruitment of the prefrontal cortex regions have shown to occur (Casey, Jones, & Somerville, 2011). A reactivation of the hypothalamus-pituitary-gonadal-axis leads to the initiation of pubertal changes and is also likely to influence brain maturation and action (Peper & Dahl, 2013; Sawyer et al., 2012). Until the ventral striatum and pre-cortical areas reach a similar maturation level, and the control areas of the brain manage to decelerate the reactivity of the nucleus accumbens and the amygdala, the adolescent brain is likely to be vulnerable to external stimuli such as environmental exposures, which may lead to acting without hesitation, and risk-taking behaviour in a broad sense (Casey, Getz, & Galvan, 2008; Casey et al., 2011). Exposure to stress, in turn, may damage a young brain (Eiland & Romeo, 2013) and have long-term effects on, for example, mental health (Romeo, 2017). However, owing to the developmental plasticity of the adolescent brain, this time period may also provide opportunities to alter the course of detrimental directions (Eiland & Romeo, 2013).

2.1.3 Early adulthood

The transition from adolescence to early adulthood is defined as occurring between 18 and 25 years of age (Arnett, 2000). Early adulthood is operationalized as the time period during which the extensive changes and maturation in biological and

psychological divisions are likely to decrease and the 'lines of life' to become established in relation to education, participation in working life, and starting a family (Bonnie, Stroud, & Breiner, 2015). An individual starts to live an autonomous, independent adult life as a productive part of society (Bonnie et al., 2015). Although young adults have better health than adults, the transition phase is likely to be the initial stage of various health disorders that continue into adulthood (Costello, Copeland, & Angold, 2011; Kessler et al., 2007).

2.2 Unhealthy behaviours and psychosocial problems during adolescence

Health behaviours are a range of activities and choices a person makes during their lifetime. They often have roots in childhood and adolescence (e.g. Simmonds et al., 2015; U.S. Department of Health and Human Services, 2012) and are usually distributed into healthy and unhealthy behaviours, i.e. those thought to be favourable for health, and those thought to be unfavourable for health. For most behaviours, categorization is quite straightforward: for example, smoking vs no smoking; but for others, categorization is more multidimensional: for example, eating behaviour. Of the different health behaviours, the present study focused on overweight/obesity, physical activity, sleep behaviour, sedentary behaviour, and smoking.

Psychosocial problems are understood as a broad spectrum of psychological and social environment hardships. They include internalizing (e.g. anxiety) and externalizing symptoms (e.g. aggressive behaviour), and/or socially related unpleasant feelings (e.g. feelings of loneliness) and are often divided into two main categories: internalizing and externalizing problems (Achenbach & Rescorla, 2001). Problems is a wider term in contrast to symptoms and feelings, and might include a wide range of symptoms, syndromes or disorders, depending on the study's scope. It is important to distinguish clinically diagnosed psychosocial or psychiatric disorders such as depressive disorder or conduct disorder, often characterized by an accumulation of different symptoms causing functioning impairment (American Psychiatric Association, 2013; Bianchi et al., 2017), from reported symptoms or feelings.

2.2.1 Prevalence and changes in recent decades

Overweight/obesity

Weight problems are a major issue among children and adolescents worldwide. In developed countries, 23–24% of children and adolescents, and in developing countries 13% are currently overweight or obese (Ng et al., 2014). During the last 30 years, the number of overweight/obese young people has more than doubled, and the rate of increase among them has been even higher than that among adults (Ng et al., 2014). At the moment, it seems that the rise has somewhat plateaued in high-income countries, but in developing countries, prevalence rates are still escalating (NCD Risk Factor Collaboration, 2017; Ng et al., 2014).

Physical activity

WHO recommends at least 60 minutes of moderate- to vigorous-intensity physical activity (MVPA) per day for children and adolescents, along with at least three sessions of vigorous-intensity activity per week. According to systematic reviews and a comparison study of 34 countries, 15–40% of young people accumulate sufficient PA levels globally (Ekelund et al., 2011; de Moraes, Guerra, & Menezes, 2013; Guthold, Cowan, Autenrieth, Kann, & Riley 2010), whereas among European children and adolescents, the prevalence has varied between 5% and 60%, depending on the measurement used (Van Hecke et al., 2016). After the 1990s, the percentage of young people who engage in sufficient PA levels has remained quite stable (Ekelund et al., 2011).

Sleep behaviour

The American Academy of Sleep Medicine and The National Sleep Foundation have stated that young people aged 13 to 18 should regularly get 8–10 hours of sleep (Hirshkowitz et al., 2015; Paruthi et al., 2016). Two-thirds of American adolescents sleep less than is recommended by Youth Risk Behavior Surveillance (Kann et al., 2016), and over half of Australian adolescents did not meet the recommendations in a study by Hardy, Mihrshahi, Bellew, Bauman, and Ding (2017). Canadians and Europeans seem to get slightly more sleep, with 18–30% reporting sleeping under 8 hours (Garaulet et al., 2011; Ortega et al., 2010; Roberts et al., 2017). Declines in the frequency of getting eight hours or more of sleep have

been observed in recent decades in the US in particular (Kann et al., 2016), and general sleep duration has decreased over the last 100 years (Matricciani, Olds, & Petkov, 2012).

Sedentary behaviour

Sedentary behaviour has earlier been described as not performing physical activities, i.e. equal to physical inactivity (Pate, O'Neill, & Lobelo, 2008). However, in recent years, it has been distinguished from PA as a separate, meaningful health behaviour (Pate, Mitchell, Byun, & Dowda, 2011) and defined as sitting or lying down (sleeping excluded) during which energy expenditure is 1.5 Metabolic Equivalents or less (Pate et al., 2008; Sedentary Behaviour Research Network, 2012). Generally, sedentary behaviour is built up of screen-based behaviours (e.g. television viewing, computer use) and non-screen-based activities (e.g. reading or playing an instrument; Pate et al., 2011). Guidelines recommend that the hours spent doing screen-based sedentary activities should be limited to two hours per day among adolescents (Saunders & Vallance, 2017). To date, no recommendations of total hours spent doing sedentary activities have yet been released (Tremblay et al., 2016). A recent review found that the mean total sedentary time of adolescents aged 13–18 varied between 268 and 506 minutes per day across European countries (Verloigne et al., 2016), and estimations of the proportion of time spent in sedentary activities after school hours has ranged from 28% to 89% among 12–18-year-olds (Arundell, Fletcher, Salmon, Veitch, & Hinkley 2016). According to a review and meta-analysis published in 2004, hours spent watching television have not changed since the 1970s (Biddle, Gorely, & Stensel, 2004), but newer reviews have revealed contradictory findings regarding increases in media use, especially in recent years (Bassett, John, Conger, Fitzhugh, & Coe 2015; Saunders & Vallance, 2017).

Smoking

A recent systematic analysis (GBD 2015 Tobacco Collaborators, 2017) estimated that the global prevalence of daily smoking was 11% among 15–19-year-old men and 3% among women of a similar age. The corresponding figures were 6% and 7% among 14–18-year-old men and women in Finland in 2019 (Kinnunen et al., 2019). National data from England showed that 3% of adolescents aged between 11 and 15 smoked at least once a week, and 25% reported having tried smoking (Fuller & Hawkins, 2012). In the US, 30% of 8th to 12th graders had smoked cigarettes during

the preceding month according to a report of the U.S. Department of Health and Human Services (2012). Although frequency rates are still subsequently high, regular tobacco use and the prevalence of ever-smokers have decreased since the 1990s worldwide (GBD 2015 Tobacco Collaborators, 2017; Kinnunen et al., 2019; U.S. Department of Health and Human Services, 2012).

Internalizing problems

In the Western world, 7–44% of adolescents report internalizing problems according to a systematic review and meta-analysis (Bor et al., 2014). With respect to actual mental health disorders, a review has suggested prevalence rates of 11% for anxiety disorders and 6% for depression (Costello et al., 2011). Compared to frequency rates a decade ago, internalizing problems have become more common, especially among women (Bor et al., 2014). This trend was seen in all studies using standard questionnaires to inquire about internalizing problems.

Externalizing problems

The occurrence of different externalizing problems varied between 7% and 17% in some epidemiological studies conducted in Western countries (Collishaw, Maughan, Goodman, & Pickles, 2004; Philipp et al., 2018; Sourander et al., 2012; Tick, van der Ende, & Verhulst, 2008). In a review, the proportion of adolescents suffering from any diagnosed externalizing disorder was estimated to be around 3–4% (Costello et al., 2011). According to a meta-analysis (Bor et al., 2014), the prevalence of externalizing problems has remained rather stable for a decade. However, an increasing burden among women has been observed (Bor et al., 2014).

2.2.2 Tracking from adolescence to adulthood

Unhealthy behaviours tend to track from adolescence to adulthood. Regarding obesity, recent systematic reviews and meta-analyses (Simmonds et al., 2015; Simmonds, Llewellyn, Owen, & Woolacott, 2016) have shown that the coefficients for persistence are high, and nearly 80% of obese adolescents are also obese in adulthood. Biddle, Pearson, Ross, and Braithwaite (2010) systematically reviewed sedentary behaviours and found moderate levels of tracking, with coefficients being higher in studies with shorter follow-ups. Two reviews, in turn, have been summarized PA as having low or moderate coefficients (Hallal, Victora, Azevedo,

& Wells, 2006; Telama, 2009). However, according to a systematic review and meta-analysis (Corder et al., 2019), it seems that PA declines rather than increases during the time period between adolescence and early adulthood. With respect to smoking, over 80% of adult ever-smokers report having started their smoking habit before turning 18, according to a report of the U.S. Department of Health and Human Services (2012). A United Kingdon (UK) study of a large cohort found that 29% and 14% of those having experienced sleeping disturbances at 16 years reported disturbances also at 23 and 33 years of age, respectively (Dregan & Armstrong, 2010).

2.2.3 Associations between factors

Adolescents' health behaviours and psychosocial problems associate significantly with each other. Earlier systematic reviews and meta-analyses have acknowledged relations between internalizing and externalizing problems (Wolff & Ollendick, 2006), and between health behaviours such as sedentary behaviour, weight, sleep, and PA (Costigan, Barnett, Plotnikoff, & Lubans, 2013; Dolezal, Neufeld, Boland, Martin, & Cooper 2017; Hart, Cairns, & Jelalian, 2011; Must & Parisi, 2009; Must & Tybor, 2005; Pearson, Braithwaite, Biddle, van Sluijs, & Atkin 2014; Sallis, Prochaska, & Taylor, 2000). Sedentary behaviour (Costigan et al., 2013) and sleep problems (Hart et al., 2011) have shown to have a positive association with weight status (Costigan et al., 2013; Hart et al., 2011; Must & Paris, 2009) and each other (Costigan et al., 2013). Physical activity has been negatively/inversely associated with sedentary behaviour (Pearson et al., 2014; Sallis et al., 2000), and suggested to be protective of overweight along with a low level of sedentary behaviour (Must & Tybor, 2005). In turn, the results concerning the association between PA and sleeping have been mixed (Dolezal et al., 2017; Lang et al., 2016), and Bauman et al. (2012) found no relationship between PA and weight in their systematic review.

Several systematic reviews have also related health behaviours to different psychosocial symptoms and problems (Chaiton, Cohen, O'Loughlin, & Rehm, 2009; Gregory & Sadeh, 2012; Hoare, Skouteris, Fuller-Tyszkiewicz, Millar, & Allender 2014; Pulgarón, 2013; Suchert, Hanewinkel, & Isensee, 2015; Upadhyaya, Deas, Brady, & Kruesi, 2002). The relationship between PA and better mental health is quite well-established (Biddle & Asare, 2011; Hoare et al., 2014), and sleep problems, smoking and obesity have also been associated significantly with internalizing and externalizing problems (Chaiton et al., 2009; Gregory & Sadeh, 2012; Hoare et al., 2014; Pulgarón, 2013; Upadhyaya et al., 2002). A high level of

sedentary behaviour also appears to be related to those problems (Hoare et al., 2014; Suchert et al., 2015), but of a possible relationship between sedentary behaviour and depression/depressive symptoms, varying results have been revealed (Hoare et al., 2014; Suchert et al., 2015).

2.2.4 Multiple unhealthy behaviours

During recent years, the focus of health behaviour research and guidelines has been increasingly moving from single behaviour towards multiple behaviours (Tremblay et al., 2016). Multiple behaviours refer to a person having more than one adverse habit or problem at a measured time point. Studies worldwide have estimated that approximately half of adolescents participate in multiple unhealthy behaviours (Alamian & Paradis, 2009; Dumith, Muniz, Tassitano, Hallal, & Menezes 2012; Padrón, Galán, & Rodríguez-Artalejo, 2012), and it has been suggested that this prevalence may be higher than that expected from single behaviour prevalence analyses (Alamian & Paradis, 2009, Dumith et al., 2012).

Counting the numbers of unhealthy behaviours is a prominently used technique for understanding multiple behaviours (McAloney, Graham, Law, & Platt, 2013). However, this approach is unlikely to correlate with the real world, that is, no one knows who is engaged in which behaviour, which challenges, for example, the modelling of tailored health promoting programmes. Another option is to report the frequency of the possible combinations, but the variables are restricted as dichotomized, and therefore full understanding of concurrent behaviours is limited (McAloney et al., 2013).

Latent class cluster analysis (LCA) is a one person-centred cluster analytical approach to studying a number of health-related behaviours simultaneously as well as the complex inter-relations between the included behaviours. LCA divides participants into the most similar subgroups in relation to the response patterns of the studied factors, termed *clusters* (for further information see the Statistics section).

Several previous studies have utilized LCA to explore adolescent health behaviours or psychosocial problems. Patnode et al. (2011) identified three clusters of PA and sedentary behaviour through 12 variables among 11–17-year-old American adolescents, and labelled them *Active, Sedentary and Low Media/Functional Activity*. The *Active cluster* had the highest prevalence of PA and the *Sedentary cluster* the highest prevalence of different sedentary activities. The *Low Media/Functional Activity cluster* had low to moderate prevalence of studied

behaviours. The study population, however, was only 720 participants. PA, sedentary behaviour and diet also clustered into three subgroups in a representative study of American adolescents aged between 11 and 16 (Iannotti & Wang, 2013). The first was the healthiest, the second was the unhealthiest with high sedentary activity and moderate PA levels, and the third was labelled *Typical*, with the lowest levels of PA and consumption of fruits/vegetables, and moderate levels of sedentary behaviour. A Finnish twin study of 11–17-year-olds used LCA to examine leisure time activities, including watching television, watching videos, playing computer games, listening to music, playing board games, playing musical instruments, reading, practising arts and crafts, socializing, attending clubs or scouts, practising sports and outdoor activities (Lajunen et al., 2009). It found four clusters: *Passive and solitary, Active but less sociable, Active and sociable, and Passive but sociable*.

In their study of American adolescents with a mean age of 17, Olino, Klein, Farmer, Seeley, and Lewinsohn (2012) explored externalizing and internalizing symptoms. They found four clusters: low levels of symptoms, internalizing disorders, externalizing disorders, and both symptoms. Another US study by Neuman et al. (2001) applied LCA to investigate the co-occurrence of attention-deficit hyperactivity disorders (ADHD) and oppositional defiant disorder, separation anxiety and depression among female twins aged 15 on average. In this study, depression formed a separate group, and only moderate depression probabilities were observed in the oppositional defiant disorder clusters.

Only a few studies have used LCA to evaluate simultaneous mental health problems and unhealthy behaviours/health risk behaviours among adolescents (Dembo et al., 2012; Luk, Wang, & Simons-Morton, 2012; Noel et al., 2013). In their study, Noel and co-workers (2013) divided their New Zealand adolescents aged 12–19 into *Healthy* (low prevalence of included factors), *Distressed* (high levels of depressive symptoms and multiple health concerns), *Risky* (the highest prevalence of risk behaviours and subsequent low rates of depression), and *Multiple* (high levels of both risk behaviours and depression) subgroups. Luk et al. (2012) assessed subgroup problem behaviour and substance use among 6^{th}–10^{th} graders in the US and observed that these factors accumulated. Other clusters constituted non-involvement, pure bullying or substance use. Dembo et al. (2012) instead found two clusters among 12–17-year-olds that they labelled *High risk youth* and *Low risk youth* in relation to prevalence of delinquency, ADHD score, utilization of services for internalizing/externalizing problems, traumatic events, and having a diagnosis of substance abuse. The *High risk youth cluster* was characterized by high rates and the low risk by low rates of the above-mentioned factors. However,

in the aforementioned studies, the focus was on risk-taking or criminal behaviour rather than on health behaviours, and the mental health problems were described as only depressive symptoms in the study by Noel et al. (2013) and as bullying behaviour in the study by Luk et al. (2012). Moreover, the study population of Dembo et al. (2012) was drawn from participants who were in the juvenile justice system, not the general adolescent population.

LCA can be used to find distinct and meaningful subgroups of adolescents in terms of multiple health-related behaviours. Earlier studies have mainly only focused on activity patterns (PA and sedentary behaviour) or risk-taking behaviour and mental health problems, and only one prospective study (Lajunen et al., 2009) of adolescents has estimated the relevance of clusters to later health outcomes. Lajunen at al.'s study estimated the associations between the clusters and overweight, but only followed the participants until the age of 17. Therefore, more studies are needed to further address the multiple behaviour patterns in a representative sample of adolescents and to clarify the significance in relation to health issues. To date, no published study of adolescents has concurrently explored unhealthy behaviours and psychosocial problems in a general adolescent population.

Possible determinants of clustering/multiple behaviours

Several social and environmental factors have been recognized as influencing psychosocial problems and engagement in multiple unhealthy behaviours during childhood and adolescence. LCA cluster studies have observed differences between clusters in terms of age (Liu, Kim, Colabianchi, Ortaglia, & Pate 2010; Luk et al., 2012) and gender (Liu et al., 2010; Luk et al., 2012; Olino et al., 2012) as well as a number of other sociodemographic characteristics such as family living arrangements (Patnode et al., 2011) and family income (Liu et al., 2010). Furthermore, Iannotti and Wang (2013) found that one cluster of their study differed from other clusters in terms of depressive symptoms and race/ethnicity, and Olino et al. (2012) acknowledged that some of the clusters were different in terms of education attainment and recent unemployment. One twin study has suggested that genetics may have a possible influence on class membership (Neuman et al., 2001).

Among other multiple behaviour cluster studies, two systematic reviews have also highlighted the influence of age and gender on the clustering of multiple health behaviours (Ferrar, Chang, Li, & Olds, 2013; Leech, McNaughton, & Timperio, 2014). In addition, socioeconomic status (SES) (mainly defined by parental

education/income) and ethnic background have been found to relate to patterns. Prior studies not estimating psychosocial/psychological symptoms have noticed differences between subgroups in terms of these factors (Mistry, McCarthy, Yancey, Lu, & Patel 2009; Veloso, Matos, Carvalho, & Diniz, 2012), and in terms of engagement in a number of health behaviours (Padrón et al., 2012; Pronk, Peek, & Goldstein, 2004). Participating in one unhealthy behaviour is likely to induce adherence to other health risk manners (Driskell, Dyment, Mauriello, Castle, & Sherman 2008; de Winter, Visser, Verhulst, Vollebergh, & Reijneveld 2016), and peer and parental behaviours may also play a determinant role (Alamian & Paradis, 2012).

2.2.5 Influence on health

Unhealthy behaviours and psychosocial problems arising in childhood/adolescence play a role in young adult or adult health (Gore et al., 2011; Johnson, Dupuis, Piche, Clayborne, & Colman 2018; Kessler et al., 2007), and the health effects of accumulated behaviours are likely to be additive or interactive (Loef & Walach, 2012; Saunders et al., 2016; Stampfer, Hu, Manson, Rimm, & Willett 2000). For instance, one systematic analysis observed that PA, tobacco use and overweight/obesity in adolescence were related to overall disease burden in adulthood (Gore et al., 2011). A systematic review by Johnson et al. (2018) found that adolescent depression increases the risk of adult mental health problems. In a review by Saunders et al. (2016), children and adolescents with a combination of high PA, adequate sleeping hours and a low level of sedentary behaviour had good measures of cardiometabolic health in comparison to those with less favourable patterns of these behaviours.

2.3 Musculoskeletal pain in adolescence

MS pain refers to pain in the musculoskeletal system, i.e. pain in the muscles, tendons, ligaments and/or bones in the neck, arms, back, legs, knees, feet, and hands. Generally, pain has been defined as an ‘unpleasant sensory and internalizing experience associated with actual or potential tissue damage or described in terms of such damage’ (Bonica, 1979). MS pain can be divided into acute, subacute (six weeks to three months) or chronic pain (at least three months), and pain intensity, frequency and especially pain-related disability, such as activity limitations and participation restrictions, are likely to characterize its significance.

Of the statistical terms used in MS pain epidemiological research, the *prevalence of pain* indicates the number of individuals with pain in a studied population at a certain time point (point prevalence) or interval (period prevalence), or at some time point during one's lifetime (lifetime prevalence). *Incidence of pain* measures the rate of new cases of pain that arise during a given time period. The use of the term 'incident' in research always requires a prospective setting. The definition of the persistence of pain, in turn, often collaborates with that of 'chronic or 'recurrent' pain', the latter of which also includes a follow-up period. A *risk factor* is a variable that increases the likelihood of developing the studied outcome. A *determinant* also includes the definition of a risk factor but a causal relationship with the outcome is not necessary. The most widely used tools for gathering pain information are questionnaires, along with interviews, clinical examinations or a combination of these (Calvo-Muñoz et al., 2013; Jeffries, Milanese, & Grimmer-Somers, 2007).

2.3.1 Single-site musculoskeletal pain

Prevalence

Single-site pain means pain in one site of the MS system at a specified time point or time period. Nearly all adults claim to have experienced MS pain at some point in their lives (Woolf & Pfleger, 2003), and the prevalence rate appears to increase with age (Hoy et al., 2012; March et al., 2014).

LBP has been defined as 'pain limited to the region between the lower margins of the 12th rib and the gluteal folds' (Anderson, 1977). It is the most common form of back pain. In a meta-analysis of 10 studies by Calvo-Muñoz et al. (2013), the mean point prevalence and the mean period prevalence of LBP among under 18-year-olds during the preceding 12 months were 12% and 33%, respectively. Similarly, an overview of systematic reviews observed the point prevalence of back pain as ranging from 3% to 39% and monthly prevalence from 10% to 36% (Kamper, Yamato, & Williams, 2016). In the meta-analysis (Calvo-Muñoz et al., 2013), the mean lifetime prevalence among children and adolescents was 40%, while Jones and MacFarlane (2005) and Jeffries et al. (2007) in their reviews observed that some studies reported a lifetime LBP prevalence as high as 70–80% before the age of 20. According to a systematic review by Hoy et al. (2012), the prevalence of LBP increases during school years especially, until the age of 18 to

20, and after the twenties a slight decrease occurs before a new upturn during the thirties. In a recent systematic review of the natural course of LBP across childhood to early adulthood, 1–10% of the participants had repeated reports of LBP and LBP fluctuated among 16–37% (Junge et al., 2019). The incidence rate of LBP during childhood and adolescence has been estimated as ranging between 11% and 21% over a maximum two-year period (Jeffries et al., 2007; Jones & MacFarlane, 2005). Generally, LBP tends to be more prevalent among women than among men (Hoy et al., 2012; Jones & Macfarlane, 2005; Kamper et al., 2016).

Relatively few young people with LBP seek medical care due to pain. Sixteen per cent of Danish adolescents suffering from LBP at the age of 13 to 16 had sought medical help for LBP (Harreby et al., 1999), whereas in a study of the participants of the Oulu Back Study (OBS), 16% of 18–19-year-old Finns with LBP had consulted a health care professional due to the pain (Tiira et al., 2012). A Chinese study reported rates of 12–20% among 10–18-year-old students with LBP (Yao, Mai, Luo, Ai, & Chen 2011). In an English study, the percentage was 23% among 11–14-year-olds (Watson et al., 2002); and in an Australian study, 37% among 17-year-olds (O'Sullivan, Beales, Smith, & Straker, 2012). The majority of adolescent LBP with addressable aetiology is related to an acute injury or overuse of the MS system (MacDonald, Stuart, & Rodenberg, 2017), but in most cases, no patho-anatomical cause can be identified (Houghton, 2010; MacDonald et al., 2017).

In summary, LBP is surprisingly common among adolescents, with estimations varying between 3% and 39% (point prevalence), 10% and 36% (monthly prevalence), and 40% and 80% (lifetime prevalence). The great variability in the analyses is likely to be explained by the heterogeneity of the pain definitions used and study populations studied. LBP appears to especially affect older adolescents and women. Nonetheless, a relatively low number of young people with LBP visit a health care professional or are affected by persistent LBP across childhood to early adulthood, indicating that most adolescent LBP may be short term and transient. Still, we do not know which kind of pain is relevant at which age or the prevalence of consequential pain (Kamper et al., 2016).

Influence on health and well-being

Several systematic reviews and epidemiological studies have established the significance of MS pain, especially LBP, for health and well-being. Globally, MS conditions are among the most common causes of years lived with disability (Global Burden of Disease Study 2013 Collaborators, 2015; Vos et al., 2012) and

disability-adjusted life years, including both death and disability (Murray et al., 2012). In Western countries, they are among the leading causes of work disability (Swedish Council on Technology Assessment in Health Care, 2004). In addition, individuals suffering from MS pain/LBP are likely to face social inequalities, to be exposed to a loss of social identity (Hartvigsen et al., 2018), and to have higher levels of psychological problems (Bair, Robinson, Katon, & Kroenke, 2003; Coggon et al., 2013). The health-related quality of life connected to, for example, social relationships and activities, is also likely to be threatened (Froud et al., 2014). A systematic review and meta-analysis by Williams et al. (2018) evaluated that MS conditions may also increase the risk of chronic diseases such as cardiovascular disease or diabetes in comparison to those with no MS problems.

Possible health behaviour, psychosocial and demographic determinants of MS pains in childhood and adolescence

The profile of determinants of MS pain among children and adolescents tends to be multidimensional, with several health behaviours and psychosocial and demographic factors having an effect. A systematic review and meta-analysis by Huguet et al. (2016) summarized 36 longitudinal studies examining the potential determinants of the onset and persistence of adult MS pain recognized in childhood or adolescence. Nearly half of the studies included evaluated back pain. SES, internalizing problems, and smoking were found to play a role in the development of MS pain. Exercising regularly protected against the onset of MS pain. Older age and negative internalizing symptoms increased the risk of persistent MS pain. Along the same lines, an overview of systematic reviews highlighted the influence of psychosocial symptoms, female gender, and smoking on the risk of back pain (Kamper et al., 2016). Two systematic reviews (Brink & Louw, 2013; Prins, Crous, & Louw, 2008), in turn, found sitting time to associate with upper quadrant MS pain. However, almost all the papers reviewed were cross-sectional. A systematic synthesis of cross-sectional studies discovered a significant association between overweight/obesity and MS pain/LBP, but longitudinal analyses found no such relation (Paulis, Silva, Koes, & van Middelkoop, 2014). According to a meta-analysis by Gini and Pozzoli (2013), bullying-victimized adolescents are more likely to suffer from different symptoms, including MS pain.

In conclusion, strong evidence exists that diverse health-related behaviours are related to MS pains among adolescents. The significance of smoking and psychosocial problems in particular has been emphasized. However, a substantial

amount of studies rely on a cross-sectional setting and/or are low in quality. Thus, additional research is essential.

2.3.2 Multisite musculoskeletal pain

The term 'multisite pain' applies when a person concurrently experiences pain in more than one location or alternatively at a measured time point/period. No specific standardized definition of multisite pain exists yet, but several previous studies have found that the number of pain sites (NPS) characterize multiple pains (e.g. Carnes et al., 2007; Kamaleri, Natvig, Ihlebaek, Benth, & Bruusgaard 2008). Another outcome used is widespread pain (WSP), which is defined by the American College of Rheumatology as the presence of pain on the right and left sides of the body, above and below the waist and axial skeletal pain lasting over three months (Wolfe et al., 1990). This partly mirrors the criteria for fibromyalgia, the latest of which were published in 2010, and instead of WSP, included a Widespread Pain Index, which largely follows the NPS concept (Wolfe et al., 2010). In their study, Beasley and MacFarlane (2014) concluded that 'the use of a measure that looks at the NPS rather than a particular distribution is acceptable as a diagnostic criterion'. The focus of this thesis is on MMSP rather than single-site pains.

Prevalence and tracking

MMSP is a common problem among adolescents. In a Norwegian study by Hanvold, Lunde, Koch, Wærsted, & Veiersted (2016), 69% of 17-year-olds suffered from MMSP. Another Norwegian study (Eckhoff et al., 2017a) discovered that 51% of women and 35% of men had MMSP among adolescents aged 16 years. Eckhoff et al. (2017a) also surveyed MS pain-related functional impairment but did not provide the prevalence rates for functional impairment related to MMSP. In an Australian study (Rees, Smith, O'Sullivan, Kendall, & Straker 2011), the prevalence of having both back and neck pain was 13% among 14-year-olds. In studies conducted in Finnish populations, 43% of men and 63% of women who were Northern Finland Birth Cohort 1986 (NFBC1986) members at the age of 16 (Paananen, Taimela, et al., 2010), and 15% of 10–17-year-olds reported pain in more than one site (Kujala, Taimela, & Viljanen, 1999). The latter figure referred to pain interfering with schoolwork or leisure activities. The frequency rate of having another pain site in addition to back pain or lower limb pain was 22% among

Swiss and Spanish 15-year-olds (Pellisé et al., 2009) and approximately 50% among Finnish 10–12-year-olds (El-Metwally, Salminen, Auvinen, Kautiainen, & Mikkelsson 2006). Using LCA, Dianat, Alipour, and Asghari Jafarabadi (2018) revealed that 7% of Iranian adolescents aged between 11 and 15 belonged to a cluster with a high likelihood of neck pain, shoulder pain, upper back pain and LBP. Congruently, a *Widespread pain* cluster consisted of 8% of English young people at the age of 11–14 in a study by Adamson, Murphy, Shevlin, Buckle, and Stubbs (2007). These prevalence rates being lower than those in other studies is likely to be due to the strict pain characteristics among the clusters, i.e. an individual had to have all the pain sites studied. According to a Finnish study of university students, MMSP co-occurred slightly more often in the 2010s than in the 2000s (Oksanen, Laimi, Löyttyniemi, & Kunttu, 2014).

Regarding recurrent MMSP, 47% of Norwegian participants had MMSP at 17 years and still later, at six-year follow-up (Hanvold et al., 2016). Paananen, Taimela, et al. (2010) found that 33% of men and 55% of women reported MMSP at 16 and 18 years, respectively. In turn, chronic idiopathic MMSP in three or more locations was reported by only 9% of Norwegian adolescents aged between 13 and 18 (Hoftun et al., 2011). However, the latter study did not include those with two-site MS pain. Among 7–18-year-old American children and adolescents with diagnosed chronic pain (of which most was MS pain), 63% characterized the pain as occurring in multiple sites (Basch et al., 2018). In studies by Mikkelsson, Sourander, Salminen, Kautiainen, and Piha (1999) and Mikkelsson et al. (2008) of Finnish children with a mean age of 10 and 12, respectively, WSP persisted among 28% over the one-year follow-up, but only 1% of all participants had WSP at baseline and at one-year and four-year follow-ups. The prevalence of chronic WSP was also low among 17-year-old British adolescents at 4%, but it is noteworthy that the data were available for only under half of the participants (Harrison, Wilson, & Munafò, 2014).

Two Norwegian follow-up studies found that mean NPS remained relatively stable over the follow-up periods of 11 years (Mundal et al., 2016) and 14 years (Kamaleri, Natvig, Ihlebaek, Benth, & Bruusgaard 2009), and a Finnish study acknowledged a tendency for MMSP to persist over 28 years from midlife to older age (Neupane et al., 2018). Kamaleri, Natvig, Ihlebaek, Benth, and Bruusgaard (2009) found stability to be across all age groups, suggesting that the pain pattern may be established already during early adulthood. Hanvold et al. (2016), in turn, proposed that NPS might be stabilized even earlier in adolescence.

In conclusion, multisite pain is a condition already frequently experienced by 10- to 18-year-olds. From 1- to 12-month periods, prevalence rates ranged from 7% to 69%, and persistence/recurrence rates between 1% and 55%, depending on the country, method and pain expression applied. It seems that NPS stabilized in adolescence, but this needs to be further explored. In general, limited data were available on the prevalence of MMSP with disabilities.

Influence on adolescent and adult health and labour market outcomes

MMSP has been linked to health and well-being in adolescence and adulthood. Longitudinal analyses of 16-year-olds from Finland and Norway found adolescents with MMSP to be at risk of psychological distress and anxiety in a two-year follow-up (Auvinen et al., 2017) and of mental health problems in a five-year follow-up period between the ages of 18–20 and 23–25 (Eckhoff et al., 2017a). In three cross-sectional studies of Swedish 8–16-year-olds (Holm, Ljungman, & Söderlund, 2012), of Finnish 19-year-olds (Paananen et al., 2011), and of Brazilian 11–15-year-olds (Gonçalves, Mediano, Sichieri, & Cunha, 2018), NPS was associated with lower health-related quality of life. A Norwegian cross-sectional study (Hoftun et al., 2011), in turn, observed that chronic MS pain in three or more locations was significantly related to pain-associated disabilities such as difficulties falling asleep and participating in PA because of pain. Among adults, relationships have been found between MMSP or widespread pain and functional problems (Kamaleri, Natvig, Ihlebaek, & Bruusgaard, 2008; Rabbitts, Holley, Groenewald, & Palermo, 2016), overall health (Kamaleri, Natvig, Ihlebaek, Benth, & Bruusgaard 2008) and mortality (McBeth et al., 2009). Furthermore, adult studies have suggested that an additional pain site might increase the risk of a single-site pain becoming chronic (Thomas et al., 1999) or widespread (Larsson, Björk, Börsbo, & Gerdle, 2012), and may complicate recovery from chronic single-site pain (Nordstoga, Nilsen, Vasseljen, Unsgaard-Tøndel, & Mork 2017). A number of publications have established that health-related risks are likely to be worse as NPS increases (see e.g. Hoftun et al., 2011; McBeth et al., 2009; Paananen et al., 2011).

MS pain in multiple locations appears to hamper labour market participation. A single adolescent study, conducted among Norwegians aged 15–16, found a linear relationship between adolescent MMSP and receiving medical and social welfare benefits after a follow-up period of over six years (Eckhoff, Straume, & Kvernmo, 2017b). An adult follow-up study found a clear dose-response relationship between NPS and poor work ability among Finnish food processing

workers after a four-year follow-up (Neupane, Miranda, Virtanen, Siukola, & Nygård 2011). NPS was related to long-term sickness absence in an exposure-response manner across a follow-up period of four years among Danish study participants registered by general practitioners at a primary medical centre (Mose, Christiansen, Jensen, & Andersen, 2016), and MMSP was recognized as a specific predictor of persistently high work absenteeism in a trajectory model of seven-year sickness absence data in a nationally representative sample of Finnish workers (Haukka et al., 2013). In addition, Haukka et al. (2015) revealed a dose-response association between MMSP in 2000–2001 and register-based disability pensions in 2000–2011. Similar associations have also been observed between NPS and disability pension among Norwegians (Kamaleri, Natvig, Ihlebaek, & Bruusgaard, 2009).

In summary, MMSP seems to associate with health-related quality of life, pain-disabilities, psychological problems, and even mortality, and individuals with multisite pain are likely to manage less well in labour market. However, the number of adolescent studies is highly limited, especially with respect to labour market outcomes, and only a few of the published adolescent studies have applied a longitudinal analytical approach.

Possible determinants in adolescence

Several possible determinants of MMSP have been discovered among children and adolescents. A study by Eckhoff and Kvernmo (2014) observed relationships between mental health problems, sedentary behaviour, PA, and MMSP among 10th grade Norwegians. An Australian study of 14-year-olds (Rees et al., 2011) also found an association between Youth Self-Report (YSR)-measured psychosocial problems and co-occurring back and neck pain. MMSP was more often reported by Finnish young people with high levels of PA (Kujala et al., 1999), whereas Wirth and Humphreys (2015), in turn, provided evidence of a relationship between sleep problems and pain in more than one spinal area among Swiss 11–16-year-olds. In the LCA work of Adamson et al. (2007), odds ratios (ORs) for belonging to a widespread pain cluster were higher among older adolescents, women, those with heavy school bag weight relative to body weight, or those who carried their bag in some other way than by using both shoulder straps, and adolescents with schoolwork difficulties and headaches. The above studies were all conducted using a cross-sectional design.

In the longitudinal analyses of MMSP, smoking, overweight/obesity, alcohol use, physical inactivity, and moderate level of PA among Finns at the age of 16 predicted significant MMSP 15 years later (Puroila, Paananen, Taimela, Järvelin, & Karppinen 2015). The significance of smoking was emphasized in the risk of NPS among Norwegian technical students in a 6.5-year follow-up (Hanvold et al., 2016). Associations have also been observed between SES, physical workload, high demands at work, and perceived MS tension and NPS (Hanvold et al., 2016). Single-site MS pain has a tendency to co-occur with pain in another site (Mikkelsson et al., 2008; Silva, Couto, Queirós, Neto, & Rocha 2018), which has been suggested to be relevant, regardless of demographic or health-related factors (Silva et al., 2018).

Psychosocial symptoms, high levels of PA and other somatic symptoms were associated with WSP among English adolescents at the age of 11–14 in both cross-sectional and prospective settings (Jones, Silman, & Macfarlane, 2003). A study by Mikkelsson et al. (2008) recognized older age, female gender and depressive feelings at 10–12 years as independent determinants for the onset of WSP over one- and four-year follow-ups, whereas a UK study found sleep problems at 15 years to be associated with WSP two years later (Harrison et al., 2014). Problematic sleeping was also related to greater pain severity among WSP adolescents. Children in a British cohort who had faced familial financial hardships, experienced maternal death or resided in institutional care at seven years were at an increased risk of adulthood WSP (Jones, Power, & Macfarlane, 2009). A recent review estimated that around a half of (chronic) WSP can be explained by shared genetic factors (Kerr & Burri, 2017).

The few studies exploring the potential determinants of persistent/recurrent MMSP have been conducted among the study population of the present study (NFBC1986). In a study by Paananen, Taimela, et al. (2010), externalizing problems, long sitting time among men, internalizing problems, a high level of PA, short sleeping time, and smoking were observed to associate with MMSP at 16 and 18 years. Jussila et al. (2014) formed LCA clusters of MS pains during a two-year follow-up and evaluated the probability of belonging to different clusters. In their analyses, internalizing and externalizing problems among both genders, long sitting time and short sleeping time among men, and alcohol use among women increased the likelihood of belonging to the cluster with a high probability of MMSP across the follow-up.

In summary, a wide spectrum of social, gender-, and health-related determinants of multisite pain have been identified and the number of longitudinal

studies has been relatively high. Even so, proportionally few studies have focused on late adolescence, during which the prevalence of MMSP tends to be the highest. Moreover, no study has evaluated the possible influence of accumulated adverse health-related behaviours on recurrent MMSP. Yet it has been suggested that the increasing number of adverse health-related behaviours and the risk of MMSP may be linked (Paananen, Auvinen, et al., 2010).

2.4 Participation in labour market during early adulthood

One significant part of the transition from adolescence to adulthood is graduation and integration into working life. Eurofound has even proposed that successful labour market inclusion denotes the final transition into adulthood (Eurofound, 2017). The global parameters evaluating labour market participation/inclusion include employment and unemployment rates and the labour force participation rate (Eurofound, 2017; ILO, 2017). An *employed person* has been defined as an individual receiving pay or profit for at least one hour per week or who is temporarily out of work due to illness, leave or industrial action. An *unemployed person*, in turn, currently has no job but is actively seeking employment and is available to start work. Employed and unemployed people together comprise the *labour force*. The *employment rate* is measured by dividing the number of employed people by the total working population and is calculated as the ratio of unemployed people to the labour force. The *labour force participation rate* is calculated as the labour force divided by the total working-age population. A number of studies has also explored participation by using sickness absences, disability pensions, and earnings as outcomes (e.g. Helgesson, Tinghög, Niederkrotenthaler, Saboonchi, & Mittendorfer-Rutz 2017; Kari et al., 2016).

2.4.1 Inclusion figures

According to the ILO (ILO, 2017), 13% of young people aged 15–24 who were part of the labour force were without work globally in 2016, and 22% of all those of a similar age had no employment or were not in education or training (NEETs). In European countries, the youth unemployment rate exceeded the global rate (18%), but in contrast, the proportion of NEETs was slightly lower (14%). According to the statistics of Eurofound (Eurofound, 2017), of unemployed European young people, almost one third has been unemployed for over 12 months. The employment rates of these young people have varied between 32% and 35%

across European countries (Eurofound, 2017). Generally, young people comprise approximately 10% of the total labour force in Europe (ILO, 2017).

In 2016, of older Europeans aged 25–29, 11% had no job, two fifths of the unemployed were long-term unemployed, and 19% could be characterized as NEETs. The employment rate was significantly higher than that of young people, at 73%.

2.4.2 Characteristics of transition to labour market

Young people tend to change jobs several times during the transition phase (Gangl, 2002; Quintini, Martin, & Martin, 2007), experience many spells of unemployment (Quintini et al., 2007), and have more temporary employment than adults (ILO, 2017; Quintini et al., 2007). According to an analysis of the Organisation for Economic Co-operation and Development (OECD) countries, establishing permanent work after graduation is estimated to take two to six years in Europe (Quintini et al., 2007). Young people generally manage to find jobs quite easily (Axelrad, Malul, & Luski, 2018) and experience shorter unemployment spells than older individuals (Quintini et al., 2007). However, they are at a disadvantage, for example, lower wages (ILO, 2010). With respect to education, globally, today's young people stay in education longer than before (Roser & Ortiz-Ospina, 2018) and fewer continue studying straight after passing their matriculation examination, at least in Finland (Official Statistics of Finland, 2018).

2.4.3 Possible determinants

Labour market inclusion problems often result from a combination of macro-level determinants, such as policies and economics (Eurofound, 2017; Eurofound, 2012) or institutions/educational systems (Wolbers, 2007) and micro-level determinants, such as psychosocial and health-related factors (e.g. Borschmann et al., 2017; Clark et al., 2017; Sidorchuk, Hemmingsson, Romelsjö, & Allebeck, 2012); demographic factors, such as gender and age (Kelly & McGuinness, 2015); education (Bynner & Parsons, 2002; de Ridder et al., 2013); early unemployment (Hammarström & Janlert, 2000; Kelly, McGuinness, & O'Connell, 2012), and parents'/friends' education or unemployment (Alfieri, Sironi, Marta, Rosina, & Marzana 2015; Hällsten, Edling, & Rydgren, 2017). This chapter presents adolescents' internalizing and externalizing problems and unhealthy behaviours as possible micro-level determinants.

Prior literature has effectively documented the determinant role of internalizing and externalizing problems in labour market exclusion (Table 1). Two systematic reviews and meta-analyses (Bevilacqua, Hale, Barker, & Viner, 2018; Erskine et al., 2016) discovered that conduct problems that emerge in childhood and adolescence result in poor occupational outcomes in adulthood. A Swedish prospective study followed over one million men (no women included) for 36 years and found associations between psychiatric disorders at 18 years and later long-term unemployment, disability pension, and receiving welfare benefits (Löve et al., 2016). Anxiety and depression symptoms among adolescents at a mean age of 16 associated with medical benefits, including sickness absence and disability pension benefits between the ages of 20 and 29 among Norwegians (Pape, Bjørngaard, Holmen, & Krokstad, 2012). No significant relations, in turn, were observed between symptom load and later receiving unemployment benefit. In the Norwegian study, unemployment was characterized as receiving benefits for more than 180 days over one year at follow-up.

A British study (Clark et al., 2017) observed that internalizing and externalizing problems among children and adolescents aged 7 to 16 were also related to unemployment, permanent sickness, and being at home. However, only 49% of the original cohort participated in the study, and outcomes were measured using a questionnaire at 55 years. Among Swedish young adults, different internalizing and externalizing problems in childhood and adolescence predicted risks of sickness absence and disability pension across a 14-year follow-up period between the ages of 15 and 29 (Narusyte, Ropponen, Alexanderson, & Svedberg, 2017). The study suggested that the relations differ with respect to the exposure of psychosocial problems, as internalizing problems were associated with disability pension and externalizing problems with sickness absences only. A British study explored data on unemployment and found that having psychosocial problems at 11 years increased the risk of not being in self-reported full-time employment at the age of 50 (Daly & Delaney, 2013). With respect to adolescent NEET studies, poor mental health (Hale & Viner, 2018) and anxiety and depression (Goldman-Mellor et al., 2016) predicted later NEET status during late adolescence among the British.

In contrast, in an Australian study, YSR-measured internalizing and externalizing problems at 14 years had no associations with NEET status at 20 years (Moore et al., 2015). The power of the study, however, was quite weak, as only 56

Table 1. Studies of psychosocial/mental health problems in adolescence as determinants of later labour market outcomes.

Study	Location	N	Setting	Baseline exposures	Outcomes	Main findings	Main weaknesses	Strengths
Bania et al., 2019	Norway	3981	Follow-up from 15–16 to 23 and 25 years of age	Mental health problems (self-reported)	NEET status (register-based)	Internalizing problems not associated with NEET status among men	Self-reported exposures	Register-based outcome
Bevilacqua et al., 2018			Systematic review and meta-analysis of 7 studies	Conduct problem trajectories in childhood and adolescence	Poor occupational or employment outcome in adulthood	Early onset of conduct problems related to later occupational outcomes	Different methods and measures used across studies	Setting
Clark et al., 2017	Great Britain	9137	Follow-up from 7–16 to 55 years of age	Internalizing and externalizing problems (self-reported)	Unemployment, retirement, permanent sickness, homemaking/other (self-reported)	Psychosocial problems related to later unemployment, permanent sickness, and homemaking/other	Self-reports, included only 49% of original cohort	Long follow-up period, many adults' life course covariates taken into account
Daly & Delaney, 2013	Great Britain	6253	Follow-up from 11 to 50 years of age	Psychosocial problems (self-reported)	Unemployment at 50 years (self-reported)	Psychosocial problems related to unemployment	Unemployment characterized as not being in full-time work	Long follow-up period
Erskine et al., 2016			Systematic review and meta-analysis of 98 studies	ADHD in childhood/adolescence	Dismissal from employment or experienced unemployment	ADHD associated with unemployment	Quality varied among studies	Setting

Study	Location	N	Setting	Baseline exposures	Outcomes	Main findings	Main weaknesses	Strengths
Goldman-Mellor et al., 2016	Great Britain	2066	Follow-up from 12 to 18 years of age	Anxiety and depression, harmful substance use (interview-based)	NEET (interview-based)	All exposures linked to later NEET status	NEET status inquired at time of interview, age restricted to 18	Strict characterization of NEET, interviews
Hale & Viner, 2018	Great Britain	8489	Five-year follow-up of 13–14-year-olds	Mental health (self-reported)	NEET (self-reported)	Poor mental health predicted NEET status	Lack of potential mediators, self-reports	Representative study sample
Löve et al., 2016	Sweden	1609690	Follow-up from 18 to maximum of 36 years of age	Psychiatric disorder (diagnosed by physician)	Long-term unemployment, welfare support, and DP between 1990 and 2005 (register-based)	Having a psychiatric diagnosis associated with all outcomes studied	Only men included, dichotomized variables used	Statistical power, data collection methods
Moore et al., 2015	Australia	1003	Follow-up from 14 to 20 years of age	Externalizing and internalizing problems (self-reported)	NEET (self-reported)	No associations found between exposure at 14 years and outcome at 20 years	Relatively small study population, self-reports	Number of covariates taken into account
Narusyte et al., 2017	Sweden	2570	Follow-up from 8–29 years of age	Internalizing and externalizing symptoms (self-reported)	Sickness absence and DP between ages of 15 and 29 (register-based)	Internalizing problems related to DP and externalizing problems to sickness absence	Only spells of over 14 days of sickness absence included, relatively small study population	Several assessments of psychosocial problems

Study	Location	N	Setting	Baseline exposures	Outcomes	Main findings	Main weaknesses	Strengths
Pape et al., 2012	Norway	7497	Follow-up from 16 to 29 years of age	Symptom load of anxiety and depression (self-reported)	Unemployment and receiving medical benefits between ages of 20 and 29 (register-based)	High symptom load of anxiety and depression associated with receiving medical benefits, but not with unemployment	Self-reported exposures	Register-based outcome data

DP = disability pension, NEET = not in employment, education, or training, ADHD = attention-deficit hyperactivity disorder

NEETs were found. Clark et al. (2017) noted no associations between psychosocial problems and early retirement among British study participants but did observe associations with other studied outcomes. A Northern Norwegian study also reported that adolescent men with internalizing problems were associated to a lesser degree with NEET status at the age of 23 and 25 (Bania, Eckhoff, & Kvernmo, 2019). Conduct problems, in turn, related significantly to NEET status.

Longitudinal analyses have associated several health behaviours with diverse labour market outcomes (Table 2). In large Swedish studies of 50 000 to one million men aged 16–21, objectively measured low cardiorespiratory fitness and high body mass index (BMI)/obesity increased the risk of disability pension throughout the follow-ups until the age of 59 (Henriksson et al., 2019; Karnehed, Rasmussen, & Kark, 2007; Rabiee, Agardh, Kjellberg, & Falkstedt, 2015). Along the same lines, overweight adolescents/young adults aged 16–24 were at an increased risk of lower household incomes after a seven-year follow-up in a US study (Gortmaker, Must, Perrin, Sobol, & Dietz 1993), and overweight/obese 12–21-year-old Norwegians were at a risk of sickness absence and disability pension before turning 30 (de Ridder, Pape, Krokstad, & Bjørngaard, 2015). A Finnish study of a representative sample of young adults, in turn, found no relations between adolescent obesity at 14 years and adult unemployment at 31 years (Laitinen, Power, Ek, Sovio, & Järvelin 2002).

PA level at 9–15 years was positively associated with long-term earnings after a 10-year follow-up period in adulthood among Finns (Kari et al., 2016), whereas sedentary behaviour at 5–15 years predicted unemployment between the ages of 18 and 32 in a retrospective study in New Zealand (Landhuis, Perry, & Hancox, 2012). In their study, de Ridder et al. (2015) noticed that sickness absence and disability pension during early adulthood was related to earlier sleep disturbances and smoking.

A 39-year Swedish survey of nearly 50 000 men observed that ‘risk use of alcohol’ predicted disability pension before and after the age of 40 (Sidorchuk et al., 2012). In US trajectory studies across a 29-year follow-up, belonging to trajectories characterized by cigarette use (Brook, Zhang, Burke, & Brook, 2014) and marijuana use (Zhang, Brook, Leukefeld, & Brook, 2016) increased the likelihood of unemployment in mid-adulthood at a mean age of 43. Among Finnish 12–18-year-old adolescents, smoking was found to be a predictor of a developmental trajectory of later register-based unemployment (Doku, Acacio-Claro, Koivusilta, & Rimpelä, 2019). In concordance with these findings, Swiss

and Australian young adults were found to be at risk of NEET status if they had previously smoked or used cannabis (Baggio et al., 2015; Rodwell et al., 2018).

When these data are pulled together, they present relatively good evidence of the impact of psychosocial and mental health problems on poor labour market outcomes, and thus, difficulties in labour market inclusion. With respect to the characteristics of unhealthy behaviours, risk-taking behaviour and poor fitness are likely to determine several markers of labour market exclusion. However, most studies were limited to male populations, and some used a relatively low study sample (Brook et al., 2014; Zhang et al., 2016). Furthermore, other health-related behaviours, such as overweight, PA, sedentary behaviour, and sleep disturbances might also play a role in labour market inclusion, but more precise evaluation requires further research. In general, relative to the size of the problem, a fairly small number of studies have evaluated adolescents' health behaviours as determinants of young adults' integration into the labour market.

2.4.4 Significance of labour market inclusion

Labour market inclusion difficulties challenge both individuals and societies. According to earlier reviews, unemployment among young people is associated with mental health problems, health risk behaviours, lower quality of life, and occupational injuries (Hammarström, 1994; Stone, Becker, Huber, & Catalano, 2012; Vancea & Utzet, 2017). Moreover, in their systematic review and meta-analysis, Roelfs, Shor, Davidson, and Schwartz (2011) observed that the unemployed were at a significant risk of mortality, especially during the early and mid-career. Another systematic review (Herbig, Dragano, & Angerer, 2013) related long-term employment to an increased risk of mental and physical illness in the general population. The authors also concluded that the long-term unemployed were likely to carry a considerably higher burden of disease in comparison to not only the employed but also to those who are unemployed for only a short time, and that this burden may increase with the duration of unemployment. Moreover, people who have experienced long-term unemployment have less work experience and suffer deterioration of the skills needed for working, which may also cause subsequent unemployment.

Table 2. Studies of health behaviours in adolescence as determinants of later labour market outcomes.

Study	Location	N	Setting	Baseline exposures	Outcomes	Main findings	Main weaknesses	Strengths
Baggio et al., 2015	Switzerland	4758	15-month follow-up from 18–21 years of age onwards	Mental health, substance use (self-reported)	NEET (self-reported)	Mental health, daily smoking, and cannabis use related to NEET status	Only men studied and age range short, self-reports	Reverse causality explored
Brook et al., 2014	USA	806	Follow-up from 14 to 43 years of age, data collected at 7 time points	Cigarette smoking (self-reported)	Unemployment weeks experienced in last year (self-reported)	Heavy continuous and occasional smoking associated with subsequent unemployment	All participants had no data at each time point, self-reporting	Magnitude of confounding factors, follow-up points
de Ridder et al., 2015	Norway	8902	Follow-up from 12–21 to 20–29 years of age	Sleep disturbance and smoking (self-reported, BMI (measured)	Sickness absence or DP benefits (register-based) from 20 to 29 years of age	Smoking, sleep disturbance, and overweight/obesity associated with receiving benefits	Self-reports, long sickness absences and education not included	High participation rate
Doku et al., 2019	Finland	43232	10-year follow-up of 12–18-year-olds	Smoking (self-reported)	Number of months of unemployment	Smoking associated with unemployment	Self-reported baseline factor	Large sample with high response rate
Gortmaker et al., 1993	USA	10039	7-year follow-up of 16–24-year-olds	Overweight (self-reported)	Household incomes (self-reported)	Overweight women at increased risk of lower incomes	Self-reports	Number of covariates

Study	Location	N	Setting	Baseline exposures	Outcomes	Main findings	Main weaknesses	Strengths
Henriksson et al., 2019	Sweden	1079128	Follow-up from 16–19 to up to 59 years of age	Physical fitness (cycle ergometer-measured) and obesity (measured)	DP from 1972 to 2012 (register-based)	Low cardiorespiratory fitness and high BMI associated with DP	Only men studied, no data on education level	Statistical power, data collection methods, additional covariate analyses
Kari et al., 2016	Finland	3596	Follow-up from 9–15 to 33–45 years of age	Physical activity (self-reported)	Annual earnings from 2000 to 2010 (register-based)	Higher level of physical activity associated with increase in annual earnings	Register-based earning measures	Reverse causation unlikely
Karnehed et al., 2007	Sweden	366929	Follow-up from 18–42 to 49 years of age	Obesity (measured)	DP from 1990 to 2001 (register-based)	Obesity increased risk of later disability pension	Only men studied	Statistical power, data collection methods
Laitinen et al., 2002	Finland	7385-9725	Follow-up from 14 to 31 years of age	BMI (self-reported)	Unemployment from 1985 to 1997 (self-reported and register-based)	Overweight/obesity did not predict unemployment	Self-reported weight/height	Collection methods of unemployment data, representative sample
Landhuis et al., 2012	New Zealand	928	Retrospective follow-up from 5–15 to 18–32 years of age	Hours of television watching (self-reported)	Months of unemployment (self-reported)	Television watching associated with unemployment among men	No adjustments for time spent in full-time education	Education taken into account

Study	Location	N	Setting	Baseline exposures	Outcomes	Main findings	Main weaknesses	Strengths
Rabiee et al., 2015	Sweden	49321	Follow-up from 18–20 to 59 years of age	Cardiorespiratory fitness (cycle ergometer-measured)	DP from 1971 to 2008 (register-based)	Low- and mid-level cardiorespiratory fitness associated with DP	Only men studied, no data on education level	Statistical power, data collection methods
Rodwell et al., 2018	Australia	1938	Follow-up from 14–15 to 20–21 and 24–25 years of age	Cannabis use, drinking behaviour (self-reported)	NEET (self-reported)	Cannabis use increased risk of NEET status, little evidence of association between alcohol use and NEET status	NEET status inquired at same time as questionnaire, self-reports	High participation rate, cohort study
Sidorchuk et al., 2012	Sweden	49321	Follow-up from 18–21 up to 57 years of age	Alcohol use, risk use of alcohol (self-reported)	DP from 1971 to 2008 (register-based)	Risk use of alcohol associated with DP before and after 40 years of age	Only men studied, no data on later alcohol use	Statistical power, register-based data on DP
Zhang et al., 2016	USA	548	Follow-up from 14 to 43 years of age, data collected at 7 time points	Marijuana use (self-reported)	Unemployment weeks experienced in last year (self-reported)	Chronic users/decreasers at increased risk of unemployment	Small study sample	Magnitude of confounding factors taken into account, follow-up points

BMI = body mass index, NEET = not in education, employment, or training, DP = disability pension

A steep increase in the share of older adults has occurred in recent years and is forecasted to continue across OECD countries (OECD, 2015). For instance, by 2050, the number of people aged 65 and over is estimated to cover one-fourth of the total population in OECD counties (OECD, 2015), which challenges the sustainability of national economics. In addition, published intervention studies have recognized poor effectiveness of employment interventions conducted among young people (Mawn et al., 2017). Young people who have not integrated into the labour market comprise an especially difficult target for effective preventive interventions. Thus, more preventive research is urgently needed to provide more opportunities to pre-empt the departure of young people from the labour market and to extend working life from the initial career phase.

3 Research questions

The research questions and hypotheses were as follows:

1. Do diverse, unhealthy behaviours and psychosocial problems co-occur and form distinct subgroups among 15–16-year-old adolescents? Does the prevalence of physical inactivity, overweight and smoking vary within these subgroups? Do these unhealthy behaviours persist in a two-year follow-up?
   Hypothesis: Unhealthy behaviours and psychosocial problems divide adolescents into distinct subgroups, within which unhealthy behaviours persist across the follow-up period.
2. Are the accumulated unhealthy behaviours and psychosocial problems associated with LBP at 16 years or with new onset of LBP at 18 years after a two-year follow-up?
   Hypothesis: Subgroups with high levels of psychosocial problems show the strongest associations with LBP both cross-sectionally and longitudinally.
3. Are the accumulated unhealthy behaviours and psychosocial problems associated with recurrent MMSP in a two-year follow?
   Hypothesis: Subgroups with both unhealthy behaviours and psychosocial problems are related to recurrent MMSP.
4. Are the accumulated unhealthy behaviours and psychosocial problems associated with register-based unemployment, employment, or permanent work disability during a five-year period at the ages of 25 and 29? Does MMSP influence the possible relations?
   Hypothesis: Subgroups with the most undesirable pattern of unhealthy behaviours and psychosocial problems are associated with all labour market outcomes. MMSP influences the possible associations.

4 Material and methods

4.1 Study population

The study population was comprised of the Northern Finland Birth Cohort 1986 (NFBC1986), which consists of all live-born children with an expected date of birth between 1st July 1985 and 30th June 1986 (n = 9479) in the two northernmost provinces of Finland (Oulu and Lapland, in bold in Fig. 2). Between May 2001 and April 2002, a questionnaire was sent to all living members of the cohort (n = 9215) to gather baseline data. A total of 7344 (80%) responded to the survey, and 6795 (76%) also participated in a health examination. At the same time, another survey was delivered to the participants' parents to elicit data on family SES. Of the parents, 6866 responded. The current study sample comprises a total of 3302 men and 3590 women (n = 6892) who provided information on both psychosocial problems and unhealthy behaviours at the age of 16. Of these, 6812 had also answered questions regarding LBP (Study II) and 6749 questions regarding MMSP (Study III) at 16 years.

In 2003–2004, the follow-up data were collected, after a subcohort of this birth cohort (n = 2969), living within 100 km of the city of Oulu (OBS), received a second postal questionnaire. A total of 2012 OBS participants, with a mean age of 18, responded. Of these, 1552 supplied data on smoking, weight, height and PA (Study I); 1625 yielded information on LBP (Study II), and 1583 reported possible existence of MMSP (Study III). All the above-mentioned participants had also responded to the first questionnaire at 16 years. Including the whole NFBC1986 in this follow-up was impossible, as participating in OBS required travelling to Oulu and resource-consuming clinical examinations.

When the participants were aged 25–29, the questionnaire data were combined with five-year (2011–2015) coverage of data on employment, unemployment, permanent work disability, parental leave, and education level from the Finnish Centre for Pensions, Statistics Finland and The Social Insurance Institution of Finland. The registers were matched using national personal identification codes. Some large statistics have also applied a similar age range in their analyses of young adults' employment (Eurofound, 2017; ILO, 2017). Between the ages of 15 and 29, 57 participants had died. Of the living participants with baseline data on unhealthy behaviours and psychosocial problems, all had registered data on the above-

mentioned factors (IV; n = 6835), and 6692 had also provided data on MMSP at 16 years. Fig. 3 presents a detailed flow chart of the study population data collection.

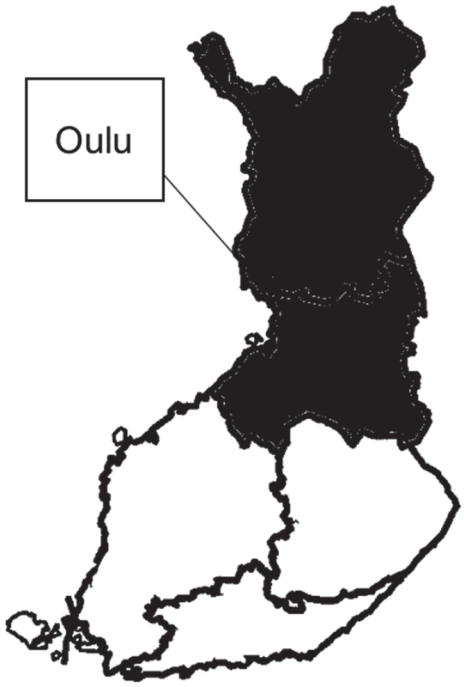

Fig. 2. The two northernmost provinces of Finland (Oulu and Lapland). This is a public domain image.

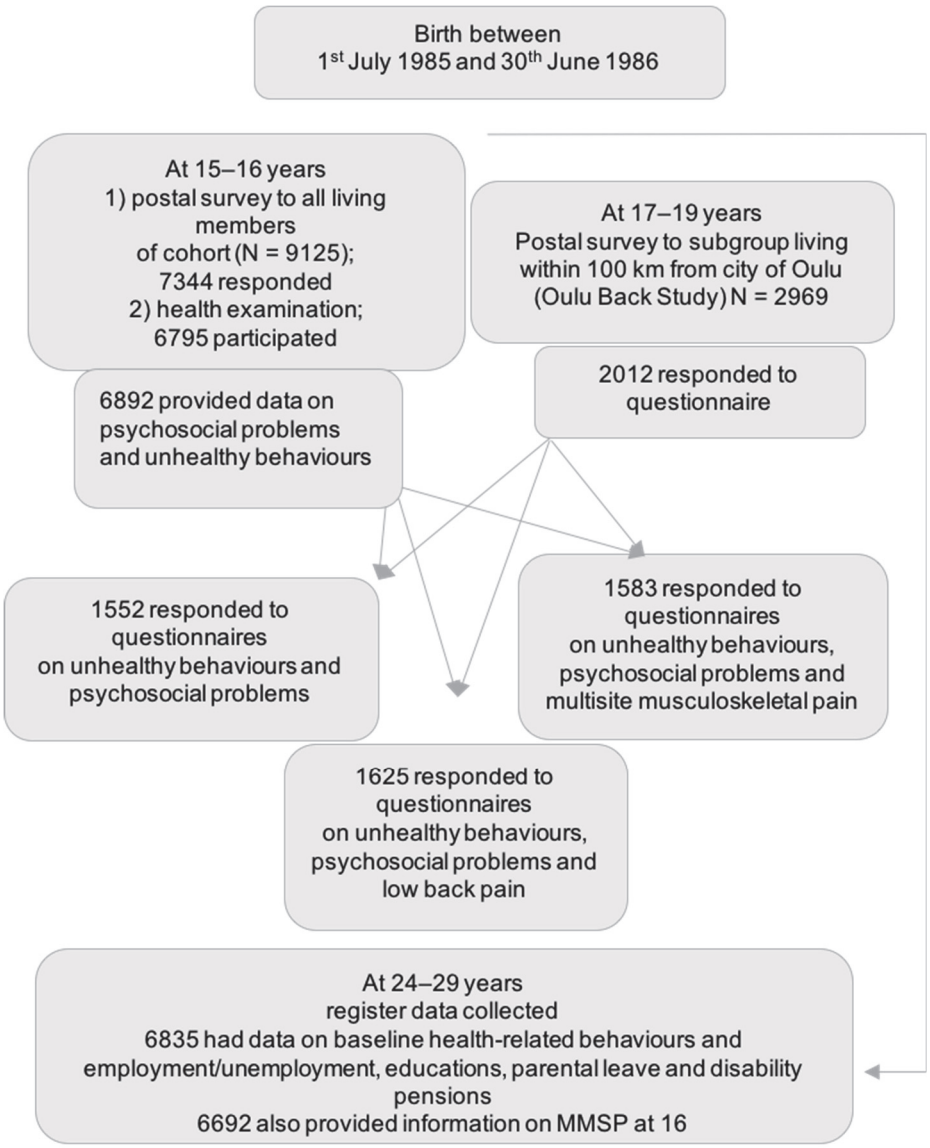

Fig. 3. Flow chart of study population collection. MMSP = multisite musculoskeletal pain.

4.2 Study outcomes

4.2.1 Unhealthy behaviours at 18 years

At 18 years, the level of PA, smoking habits and overweight/obesity were analysed (Table 3). PA and smoking were elicited in a similar way to that at 16 years (see determinant factors), and BMI relied on the self-reported values of weight and height inquired in the survey. The categories were composed as follows: '< 2 hours of MVPA/week' and '≥ 2h hours of MVPA/week' for PA, 'no smoking' and 'smoking' for smoking, and BMI of 25 or more (kg/m^2) for overweight/obesity (referred to as overweight in the follow-up analyses) (Cole, Bellizzi, Flegal, & Dietz, 2000), to estimate the persistence of adverse levels of health behaviours in particular. At follow-up, no information on sleeping was available and psychosocial problems were measured in a different way to that at 16 years. Therefore, the follow-up analyses of the first study were restricted to PA, weight status and smoking.

4.2.2 Low back pain

The outcome of the second study was self-reported LBP. LBP during the preceding six months was assessed by asking: 'Have you had any pain or aching in your low back area during the past six months?' at both 16 and 18 years. The response options were: 'No', 'Yes but I have not consulted a physician, physiotherapist, nurse, or other health professional because of my LBP', and 'Yes, I have consulted a physician, physiotherapist, nurse or other health professional because of my LBP' (Mikkonen et al., 2008). A 'Yes' response to the second question led to classifying the adolescent as 'Reporting LBP' and a 'Yes' response to the third question to a classification of 'Consultation for LBP'. Young people replying 'No' were classed as 'No LBP'. In the second study, we were especially interested in LBP leading to reporting versus consultation. In the follow-up analyses, new LBP cases were defined as those reporting LBP or having sought consultation for LBP at 18 but who were pain-free at 16 years. Figure 4 presents the anatomical area of the low back.

4.2.3 Multisite musculoskeletal pain

The outcome of the third study was self-reported recurrent MMSP. Different MS pains were elicited at 16 and 18 years by asking 'Have you had any aches or pains during the last six months in the following areas of your body?' (1) neck or occipital area, (2) shoulders, (3) low back, (4) elbows, (5) wrists, (6) knees, and (7) ankle–foot area. The adolescents responded (1) No, (2) Yes, but I have not consulted a physician, physiotherapist, nurse or other health professional because of my LBP (regarded as reporting pain), or (3) Yes, and I have consulted a physician, physiotherapist, nurse or other health professional because of my LBP (regarded as consultation for pain). Reporting pain and consultation for pain were united as one class because of our interest in the existence of pain versus no pain. For elbow, wrist, knee and ankle–foot area pains, a single pain site group was formed and defined as peripheral pain. The final pain categories were: (1) No pain, (2) One-site pain and (3) Pain in two or more sites (maximum four). Having two or more pain sites during the preceding six months at 16 and 18 years indicated recurrent MMSP in the follow-up analyses. Figure 4 shows the anatomical areas of MS pains.

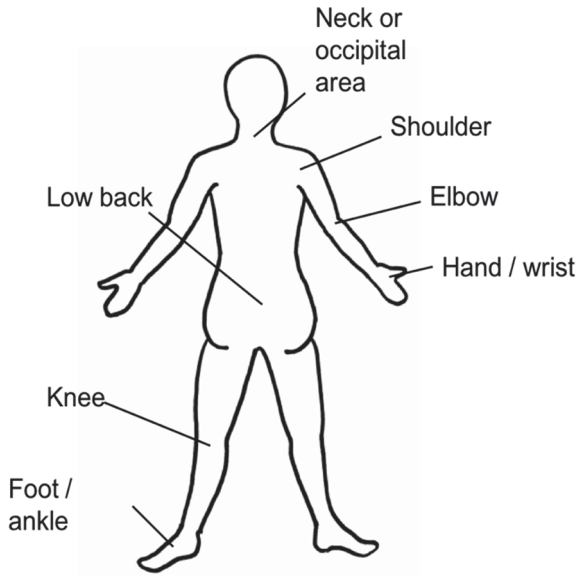

Fig. 4. Musculoskeletal pain manikin. This image was drawn by the author.

4.2.4 Labour market inclusion

The labour market outcomes of the fourth study were unemployment, employment and permanent work disability days drawn from national Finnish registers (Table 3). Those with any permanent work disability days (n = 72) during the five-year follow-up were excluded from the unemployment and employment analyses. Of the 72 participants, six had died between 15 and 29 years of age (n = 66).

Unemployment

Three categories were formed from the total number of unemployment days for which a person had received unemployment benefit between 2011 and 2015: 1) no unemployment days, 2) less than one year of unemployment, and 3) over one year of unemployment. In Finland, a person receives unemployment benefit for five days a week, and therefore 260 days or less equals under one year and more than 260 days over one year. The cut-off limit is one year of unemployment, as national statistics consider over one year of unemployment a long-term situation (Eurofound, 2017; ILO 2017).

Employment

The total number of employment days for which a participant had received income were summed up, and three categories were created: 1) no employment days, 2) under four years of employment days (≤ 1460 days), and 3) over four years of employment days (> 1460 days). Setting the cut-off limit at four years enabled better interpretation of the results than two or three years on the one hand, and ignored short-term unemployment, which is quite common among these age groups in Finland, on the other (Sutela et al., 2016).

Permanent work disability

In Finland, a person can receive a full- or part-time disability pension or fixed-term rehabilitation allowance. These disability allowances are mainly granted after sick leave has lasted for at least one year, with only few exceptions. Of all the disability benefits, a dichotomized variable, Yes vs No, was formed. If a person had received any previously mentioned disability benefits, they were categorized into the ‘Yes’ category. If a participant had had an unemployment, employment or parental leave

day and received disability pension simultaneously, the disability day was prioritized and the person was classified as having disability days, i.e. into the 'Yes' group of the permanent work disability variable. Permanent work disability is rare before the age of 30 and it is impossible to accurately perceive the preceding period of sick leave, which must last at least one year. Therefore, the above-mentioned analytical approach was used. Similar dichotomization has also been applied earlier (e.g. Narusyte et al., 2017).

4.3 Determinant factors used in LCA at 16 years

4.3.1 Psychosocial problems

Internalizing and externalizing problems

Subsequent variability exists among the assessment tools available for evaluating psychosocial symptoms. Most published studies have utilized questionnaires, followed by interviews, checklists and rating scales, and observational/externalizing methods in data collection. A significant part of these procedures relies on self-reports, parental or teacher reports, or a combination of these, but some objective methods such as different physical indicators have also been employed (Han, 2009).

In psychosocial research, the ideal symptom assessment measure has high reliability and validity, is sufficiently brief and includes clear cut-off points. Reliability refers to the overall consistency of measurements, and validity to the degree that an assessment measures what it is assumed to measure. To date, no single universal golden standard has been established for the assessment of psychosocial symptomatology (Han, 2009; Thabrew, McDowell, Given, & Murrell, 2017). In Finland, many studies have applied self-reported questionnaires, such as the YSR and the Strengths and Difficulties Questionnaire (Helstelä & Sourander, 2001; Kekkonen et al., 2015; Luntamo et al., 2012), to elicit psychosocial problems.

In the present study, the YSR questionnaire (Achenbach & Rescorla, 2001) was applied to explore internalizing and externalizing problems during the preceding six months at 16 years. This questionnaire comprised 105 items in which each person had to rate themselves on a scale of 0–2 (0 = not true, 1 = somewhat or sometimes true, 2 = very true or often true). The item points were summed and scored on eight syndrome subscales (Table 3). The scores for anxious/depressed

symptoms, withdrawn/depressed symptoms, and somatic complaints formulated the 'internalizing symptoms', while the scores for rule-breaking and aggressive behaviours made up the 'externalizing symptoms'. Subscales of 4–6 were considered 'other symptoms' and were not included in either the internalizing or externalizing scale. As regards internalizing and externalizing symptoms, the participants were classified into three categories: 1) normal range, 2) borderline range and 3) clinical range, in congruence with the recommended cut-off limits (Achenbach & Rescorla, 2001). Of the last two, a 'problem range' scale (= above the 82nd percentile) was constituted for the analyses (Helstelä & Sourander, 2001; Kantomaa, Tammelin, Ebeling, & Taanila, 2008). Adolescents with more than eight missing responses to the YSR (excluding open-ended and socially desirable items, altogether 15 items) and those missing 20% of their subscale answers were excluded. In other cases, the mean item value of the particular scale was used for substituting the missing values. As the missing data rates were low, no imputation procedures were utilized.

The documentation of the construct, criterion-related and content validity of the questionnaire have proven to be good (Achenbach & Rescorla, 2001), and a moderate-high level of associations between the YSR and various psychiatric diseases diagnosed by a structured interview has been found (Doyle, Mick, & Biederman, 2007; Ferdinand, 2007; van Lang, Ferdinand, & Verhulst, 2007). The YSR has also shown to be a reliable data collection method, with its scales' Cronbach's alpha coefficients ranging between 0.69 and 0.83 (Achenbach & Rescorla, 2001). Furthermore, the questionnaire has been widely used in Scandinavia (Broberg et al., 2001; Helstelä & Sourander, 2001; Heyerdahl, Kvernmo, & Wichstrøm, 2004) and around the world (Achenbach, Ivanova, Rescorla, Turner, & Althoff 2016).

4.3.2 Unhealthy behaviours

Physical activity

In the questionnaire, adolescents were asked to estimate their PA via the question: 'How much do you participate in (a) brisk and (b) light physical activity outside school hours?' (Tammelin, Ekelund, Remes, & Näyhä, 2007; Table 3) Brisk was specified as PA causing at least some sweating (considered moderate-to-vigorous PA = MVPA), and light as no sweating or breathlessness while active. The response

options were not at all, half an hour, about 1 h, 2–3 h, 4–6 h, or 7 or more hours per week. The focus of this study was only MVPA, as this is the form of PA in WHO's PA recommendations. Adolescents with four hours or more of MVPA per week were classified as active, 2–3 hours of MVPA per week as moderately active, and 1 hour or less of MVPA per week as inactive. Tammelin et al. (2007) recruited 86 adolescents for fitness testing at the age of 15 to 16 years to assess the test-retest reliability of the PA survey. According to two different measurements, taken about two weeks apart, the intraclass correlation coefficient was 0.78. PA at school was not evaluated as it was not addressed by the questionnaire.

Sedentary behaviour

To elicit average sitting time, the questionnaire inquired about daily hours spent watching television, reading books or magazines, playing or working on a computer, and other sedentary activities after school hours. The total amount of sitting time per day was calculated by summing up the hours that the participants reported spending on each of these activities per day, and the sum was grouped into three categories: (1) 4 hours or less per day, (2) 4.1–7.9 hours, and (3) 8 hours or more per day (Tammelin et al., 2007) among men. Among women, a continuous variable was used as it fit the LCA model better than a categorized variable. The analyses of Tammelin et al. (2007) explored the test-retest reliability of total sitting time and found the intraclass correlation to be 0.78. The questionnaire contained no questions on sitting time at school.

Sleeping time

Sleeping time was measured using one question: 'How much do you sleep on average a day?'. A three-point scale of less than 8 hours, 8–9 hours and over 9 hours was formed, based on a previous observation that 8.5 to 9.2 hours was optimal (Carskadon et al., 1980; Carskadon, Acebo, & Seifer, 2001). This is also quite close to the revised recommendations after our first study was published (Paruthi et al., 2016).

Overweight/obesity

Weight and height values were gathered via a health examination (n = 6068, participation rate 88%) and combined into body mass index (BMI; weight in

kilograms/height in metres^2). Self-reported values were used for 12% of the adolescents who had not participated in the health examination at 16 years. The following definitions were formed: 1) Normal weight: < 23.90 kg/m^2 for men and < 24 kg/m^2 for women, 2) Overweight: 23.90–28.88 kg/m^2 for men and 24–29.43 kg/m^2 for women, and 3) Obesity: > 28.88 kg/m^2 for men and > 29.43 kg/m^2 for women. These scales were assessed using the International Obesity Task Force age-specific cut-off points for BMI, corresponding to a BMI of 25 and 30 for adults (Cole et al., 2000). In the analysis, BMI was addressed as a continuous variable. Although an increase in BMI may stem from increments in lean tissues as well as in body fat tissues, linkages between weight and health issues are mainly explored in terms of BMI, not body fat, and the measurement has been found to be effective for finding obese participants among young people (Simmonds et al., 2015).

Smoking

Three questions inquired about smoking behaviour: 'Have you ever smoked?', 'Have you ever smoked regularly in your life?', and 'How much do you currently smoke?' The response alternatives were: (1) not at all; (2) casually; (3) once a week; (4) 2–4 days a week; (5) 5–6 days a week; and (6) 7 days a week for the last question along with a response option of number of cigarettes per day. Smoking was quantified as 'pack-years', which was considered to be equivalent to 15 cigarettes smoked per day for a year, because at the time when the data was collected it was quite common to use cigarette packs of 10, 'mini packs', along with normal cigarette packs of 20. Three categories: (1) non-smokers, (2) 0.1–1.0 pack-years by the age of 16 years, and (3) over 1.0 pack-years were formulated. A dichotomized variable (no smoking vs smoking) was also used in part of the analyses.

4.3.3 Confounding factors

Socioeconomic status of childhood family

At 16 years, information on family SES was collected via a questionnaire sent to the participants' parents. The father's occupation was used as an indicator and prioritized. Five classes with eight options were formulated: 1) higher clerical employees; (2) self-employed; (3) lower clerical employees; (4) workers; and (5) students, pensioners, unemployed or unknown (Table 3).

Highest education level

Statistics Finland (a Finnish public authority) provided register data on education level, which was distributed into three groups: 1) comprehensive school (‘compulsory’), 2) vocational school qualification or matriculation examination (‘secondary’), and 3) a higher education degree (‘tertiary’).

Parental leave

To form a parental leave variable, register data were gathered from The Social Insurance Institution of Finland on days during which a person had received maternity, paternity or parental allowance or home care support between the ages of 25 and 29. The variable was dichotomized as Yes vs No, since the accurate number of days could not be determined due to the policy that part of maternity leave benefits may be paid by employers.

4.4 Statistics

4.4.1 Latent class analysis

To study the accumulation patterns of unhealthy behaviours and psychosocial problems, LCA was utilized. LCA is one of the statistical techniques developed to provide a person-centred approach to characterizing and understanding heterogeneous samples. The fundamental formula of LCA is to seek uncovered but homologous subgroups of participants from an original heterogeneous population by identifying similar patterns in response items and classifying individuals into the most probable group (cluster). The idea is that participants in a certain cluster are more equal to each other than to participants in other clusters (Fig. 5). LCA assumes an unmeasured ‘latent’ categorical variable which explains the associations between the studied variables in the different clusters.

LCA has been preferred in cluster analytic literature. Its main advantages compared to other methods include its probability-based approach, formal fit indices in the determination of an optimal model, and the fact that it does not require

Table 3. Description of variables.

Variable	Assessment method	Operationalization	Questions/ example of question or other measurements	Used in studies
Internalizing problems	YSR questionnaire	Problem range vs normal range		1.-4.
Anxious/depressed	13 items		I cry a lot	
Withdrawn/depressed	8 items		I am unhappy, sad or depressed	
Somatic complains	10 items		I feel dizzy	
Social problems	11 items		I'm too dependent on adults	
Thought problems	12 items		I can't get my mind off certain thoughts	
Attention problems	9 items		I have trouble concentrating or paying attention	
Externalizing problems	YSR questionnaire	Problem range vs normal range		1.-4.
Rule-breaking behaviour	15 items		I lie or cheat	
Aggressive behaviour	17 items		I get into many fights	
Leisure time moderate-to-vigorous physical activity (hours/week)[a]	Questionnaire	< 2; 2–3; > 3 at 16 yrs < 2 and ≥ 2 at 18 yrs	'How much do you participate in (a) brisk[a] and (b) light physical activity outside school hours?'	1.-4.
Sitting time (hours/day)	Questionnaire	Continuous (among women) ≤ 4; 4.1–7.9; ≥ 8 (among men)	Open-ended question on hours spent watching TV, reading books or magazines, playing or working on a computer/playing video games and on other sedentary activities outside school hours	1.-4.
Sleeping time (hours/day)	Questionnaire	< 8; 8–9; > 9	'How many hours on average do you sleep per day?'	1.-4.
Body mass index (BMI; kg/m^2)	Health examination and questionnaire	Continuous at 16 yrs < 25 and ≥ 25 at 18 yrs	Weight and height	1.-4.

Variable	Assessment method	Operationalization	Questions/ example of question or other measurements	Used in studies
Smoking (pack-years)[b]	Questionnaire	Non-smoker; 0.1–1.0; > 1.0 at 16 yrs No smoking vs smoking at 18 yrs	'Have you ever smoked?', 'Have you ever smoked regularly in your life?', and 'How much do you currently smoke?'	1.-4.
Family socioeconomic status	Questionnaire sent to parents	Higher clerical employees; self-employed; lower clerical employees; workers; and students, pensioners, unemployed or unknown.	Father's occupation. If missing, mother's occupation.	1.-3.
Low back pain (LBP) at 16 yrs	Questionnaire		'Have you had any pain or aching in your low back area during the past six months?'	2.
Reporting LBP		Yes vs no	'Yes, but I have not consulted a physician, physiotherapist, nurse, or other health professional because of my LBP'	
Consultation for LBP		Yes vs no	'Yes, I have consulted a physician, physiotherapist, nurse or other health professional because of my LBP'	
New onset of LBP at 18 yrs	Questionnaire	No LBP at 16 yrs, but LBP at 18 yrs	'Have you had any pain or aching in your low back area during the past six months?'	2.
Reporting new onset of LBP		Yes vs no	'Yes, but I have not consulted a physician, physiotherapist, nurse, or other health professional because of my LBP'	

Variable	Assessment method	Operationalization	Questions/ example of question or other measurements	Used in studies
Consultation for new onset of LBP		Yes vs no	'Yes, I have consulted a physician, physiotherapist, nurse or other health professional because of my LBP'	
Multisite musculoskeletal pain (MMSP) at 16 yrs[c]	Questionnaire	Two or more pain sites vs no pain or one-site pain	'Have you had any aches or pains during the last six months in the following areas of your body?' Neck or occipital area, shoulders, low back, elbows, wrists, knees, and ankle–foot area	4.
Recurrent MMSP (= MMSP at 16 yrs and 18 yrs)[c]	Questionnaire	Two or more pain sites at 16 yrs and 18 yrs vs no pain or one-site pain at 16 yrs and 18 yrs	See above question	3.
Unemployment (days)	National registers	No unemployment; under one year; over one year	Days for which a person had received unemployment but no disability pension or rehabilitation benefits	4.
Employment (days)	National registers	No employment; under four years; over four years	Days for which a person had received employment benefit	4.
Permanent work disability	National registers	Yes vs no	Received disability pension or rehabilitation benefits	4.
Education	National registers	Compulsory; secondary; tertiary	Highest education level	4.
Parental leave	National registers	Yes vs no	Received parental allowance	4.

BMI = body mass index, LBP = low back pain, MMSP = multisite musculoskeletal pain, YSR = Youth Self-Report, [a]Brisk = causing at least some shortness of breath and sweating, [b] One pack-year = 15 cigarettes smoked per day in one year, [c] Consultation for pain and reporting pain combined

linear associations, normal distributions or homogeneity (Magidson & Vermunt, 2002; Muthén & Muthén, 2000). It has also been suggested as the most theoretically appropriate approach when examining the validity of the staging algorithm (Magidson & Vermunt, 2001). Thus, the use of latent variable techniques has recently significantly increased (McAloney et al., 2013).

The procedure involves first conducting a series of analyses resulting in an increasing number of subgroups. Then, from these LCA models with a varying number of classes, the most optimal model that adequately describes the study sample is chosen on the basis of a number of statistical fit indices (see next chapter). The literature has also emphasized the interpretability of the results and the conceptual meaningfulness and sizes of the clusters in the selection procedure (Collins & Lanza, 2010). For example, models with classes that include less than 5% of the participants should be excluded (Hipp & Bauer, 2006).

The statistical fit indices related to LCA are the Bayesian information criterion (BIC) (Schwarz, 1978), the sample-size adjusted BIC (SSBIC) (Sclove, 1987) and the Akaike information criterion (AIC) (Akaike, 1987), entropy, and the Lo-Mendell-Rubin test (LRT) (Lo, Mendell, & Rubin, 2001). The fitness of model increases as BIC, SSBIC, and AIC values decrease (Anderson, 2008). Entropy is an uncertainty measurement that estimates the accuracy of the classification of the participants into latent classes (Anderson, 2008). Entropy values vary between 0 and 1, and the higher the entropy, the greater the precision of the clusters' class membership, i.e. if entropy values are 1, the placement of individuals into certain clusters can be considered accurate. The LRT evaluates whether a K-class model is better than a (K-1) class model (Lo et al., 2001). If the p-value is low, the LRT stresses the superiority of the K-class model over the (K-1) solution.

4.4.2 Classification of variables used in LCA

To avoid information loss, the analyses were first created by using all the variables as continuous variables. Unfortunately, the group sizes became too small (< 5% of participants; Marsh, Lüdtke, Trautwein, & Morin, 2009) and more subgroups were observed than the factors studied, which led to the rejection of the continuous approach. Next, a variety of alternative combinations of the categorical and continuous variable in both genders were attempted. Considering internalizing and externalizing problems as dichotomized variables (Achenbach & Rescorla, 2001; Helstelä & Sourander, 2001; Kantomaa et al., 2008) and regarding PA, sleeping time and smoking as trichotomized variables among both genders represented the

current data best. Sedentary activity was trichotomized among the men and utilized as a continuous variable among the women. BMI yielded the best fit when it was continuous among both genders.

When comparing, dichotomizing and trichotomizing variables, trichotomizing is likely to be more informative than dichotomizing. This was true especially among the men, due to the PA and sedentary behaviour in the current study. Furthermore, trichotomization improved the interpretability of sleeping time in terms of optimal hours. In the case of internalizing and externalizing problems, classifying the variables into problem and normal ranges was justifiable due to the clinical perspective and easier interpretation of the results.

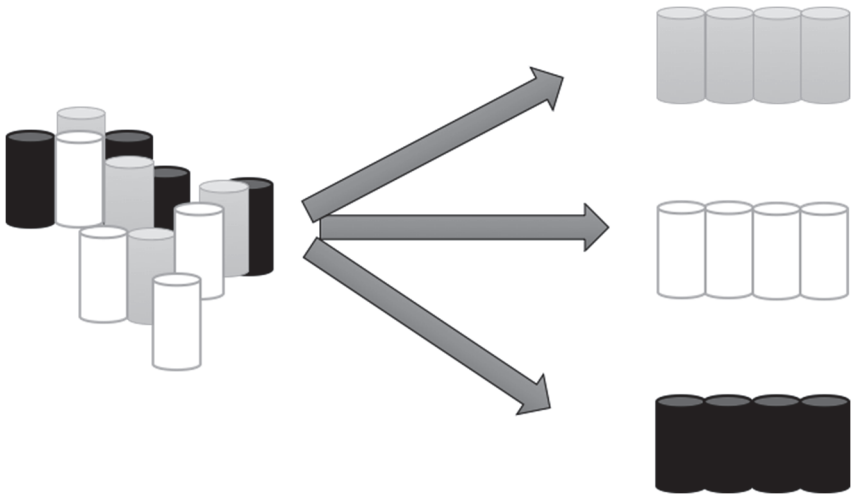

Fig. 5. Schematic modelling of latent class analysis.

4.4.3 Other statistical methods

To study the stability of the unhealthy behaviours within the clusters and the associations of the LCA clusters with self-reported LBP and new LBP, recurrent MMSP and labour market outcomes (unemployment, employment, and permanent work disability), and cross-tabulations including Chi square tests (x^2) and logistic regression analyses were used.

Study II applied log-binomial regressions with risk ratios (RRs) and confidence intervals (CIs) to evaluate the possible determinant role of LCA clusters in reporting LBP and consultation for LBP.

Study III used multinomial logistic regressions with ORs and CIs to explore the associations between LCA clusters and recurrent MMSP.

Study IV used multinomial logistic regressions with RRs and CIs to analyse the potential relations between clusters and unemployment and employment. Binomial logistic regressions provided ORs and CIs for the associations between the clusters and permanent work disability.

In the analyses, a p-value of 0.05 or under was considered statistically significant, and 95% CIs were calculated for all RRs and ORs derived. LCA was conducted using M-plus version 6.11, and SAS software version 9.1, SPSS Version 24.0 and 25.0, and STATA Version 13.1 were applied in the other analyses.

4.5 Ethics

The research protocol of the present study followed the ethical principles of the Declaration of Helsinki 1975 (ethical principles for medical research involving human subjects). The cohort participants had received written information on the use of their data for research and had provided their signed consent. The participants' parents also provided written consent at 16-year follow-up. Participation was voluntary and withdrawal from the study was possible at any time point. The data were pseudonymized by replacing identifiable information with ID codes. The Ethics Committee of the University Hospital Oulu approved the study.

5 Results

5.1 Representativeness of subsample

5.1.1 OBS participants versus others at 16 years in clusters

At 18–19 years, a subsample of the original NFBC1986 cohort (OBS) was used to evaluate the stability of the prevalence of unhealthy behaviours within the clusters, the incidence of LBP, and the recurrence of MMSP in a two-year follow-up. At 16 years, more of the participants were men (49% vs 44%, $p = 0.001$) and had a lower percentage of parents working as lower clerical employees (13% vs. 19%, $p < 0.001$) among cluster subjects not included in OBS data than the OBS participants (Table 4). Marginal differences were found in the prevalence of under 4 hours of sitting ($p < 0.005$), being normal or underweight ($p < 0.05$), and non-smoking ($p = 0.005$). No significant differences were observed in the prevalence rates of internalizing and externalizing problems, PA level, sleeping time, LBP prevalence, or MMSP ($p > 0.05$).

Table 4. Differences between psychosocial problems, unhealthy behaviours, and demographic and pain factors among OBS and other NFBC1986 cluster participants at 16 years.

Variable	Other NFBC1986 % (n)	OBS % (n)	P-value (x2)
Gender[a]			0.001
Men	49 (2562)	44 (740)	
Women	51 (2659)	56 (931)	
Family SES[a]			< 0.001
Higher clerical employees	7 (349)	8 (131)	
Self-employed	18 (960)	13 (223)	
Lower clerical employees	13 (701)	19 (323)	
Workers	40 (2099)	38 (642)	
Students, pensioners, unemployed or unknown	21 (1112)	21 (352)	
Internalizing problems[a]			0.076
Problem range	16 (835)	14 (237)	
Normal range	84 (4386)	86 (1434)	
Externalizing problems[a]			0.153
Problem range	22 (1123)	20 (332)	
Normal range	78 (4098)	80 (1339)	

Variable	Other NFBC1986 % (n)	OBS % (n)	P-value (x2)
Physical activity[a]			0.416
< 2 h/week	37 (1908)	35 (572)	
2–3 h/week	27 (1409)	27 (459)	
> 3 h/week	36 (1904)	38 (633)	
Sitting time[a]			< 0.005
< 4.1 h/day	25 (1326)	29 (486)	
4.1–7.9 h/day	43 (2254)	43 (721)	
> 7.9 h/day	31 (1641)	28 (464)	
Weight status[a]			< 0.05
Normal weight or underweight	84 (4379)	87 (1447)	
Overweight	12 (651)	10 (168)	
Obese	4 (191)	3 (56)	
Smoking[a]			0.005
Non-smoker	81 (4224)	84 (1400)	
0.1–1.0 pack-year	11 (551)	10 (168)	
> 1.0 pack-year	8 (446)	6 (103)	
Sleeping time[a]			0.696
< 8 h/day	21 (1091)	21 (352)	
8–9 h/day	65 (3422)	66 (1106)	
> 9 h/day	14 (708)	13 (213)	
LBP[b]			0.679
No	57 (2935)	57 (953)	
Yes	43 (2220)	43 (704)	
MMSP[c]			0.602
No	46 (2361)	45 (747)	
Yes	54 (2746)	55 (895)	

[a] n = 5221 (NFBC1986) and n = 1671 (OBS), [b] n = 5155 (NFBC1986) and n = 1657 (OBS), [c] n = 5107 (NFBC1986) and n = 1642 (OBS); SES = socioeconomic status, LBP = low back pain, MMSP = multisite musculoskeletal pain

5.2 Characteristics of study sample

Of the 15–16-year-old adolescents, 48% were men and 52% were women (Table 5). A higher proportion of the women than the men exercised less than two hours per week (41% vs 31%). In addition, a high PA level was more prevalent among the men than the women (45% vs 29%). Thirty-five per cent of the men, compared to 27% of the women, sat for over eight hours per day outside school hours. Almost similar percentages of the men and women were overweight (13% vs 11%) and obese (4% vs 3%), and 20% of the women and 16% of the men smoked. Only two-

thirds of both the men and women got the recommended 8–9 hours of sleep daily. The women suffered significantly more from internalizing (19% vs 11%) and externalizing problems (26% vs 16%) than the men, with the highest differences being in somatic complaints (15% vs 5%), and rule-breaking behaviour (15% vs 8%; Table 6). Most of the families of the studied adolescents belonged to the 'workers' SES class (40% of both genders; Table 5), followed by 'students, pensioners, unemployed or unknown' (21% of the men; 22% of the women), 'self-employed' (17% of both genders), 'lower clerical employees' (15% of both genders), and 'higher clerical employees' (7% of the men; 6% of the women).

5.3 Latent Class Clusters (Study I)

5.3.1 Selection of latent cluster model

To study the optimal number of LCA clusters, models with numbers of clusters varying from one to seven were tested (Table 7). Among both genders, the four-cluster solution had the best fit for the present data. Among the men, a seven-class model also provided good fit index values, but the four-cluster solution had the lowest BIC value. The conceptual meaningfulness and adequate cluster sizes of the four-cluster model also stressed the selection of the four-cluster solution. Among the women, the four-cluster model had the lowest BIC value, subsequent low AIC, SSABIC, and LRT values, and high entropy, which led to its selection.

5.3.2 Cluster characteristics

Tables 8 and 9 present the prevalence rates and mean values of psychosocial problems and unhealthy behaviours within the clusters. The men in Cluster 1 (Table 8) had the highest prevalence of externalizing (100%) and internalizing problems (31%), and smoking (46%) of all the clusters' men. They also reported moderate-high PA levels (48%). Therefore, this cluster was labelled the *Externalizing behaviour cluster* (prevalence rate 14%). Cluster 2, labelled the *Sedentary cluster* (prevalence rate 27%), represented men who were the most likely to be physically inactive (50%), to sit for over eight hours per day (68%) and to have the shortest sleeping times (39%). Eight per cent of the men belonged to Cluster 3, labelled the *Obese cluster*, which was characterized by high mean BMI (29.7) and a relatively

Table 5. Demographics of unhealthy behaviours and psychosocial problems used in latent cluster analyses and socioeconomic status of study population at 16 years.

Variable	Men (n = 3302) % (n)	Women (n = 3590) % (n)	P-value (x2)
Internalizing problems			< 0.001
Problem range	11 (363)	19 (700)	
Normal range	89 (2939)	81 (2890)	
Externalizing problems			< 0.001
Problem range	16 (524)	26 (931)	
Normal range	84 (2778)	74 (2659)	
Physical activity			< 0.001
< 2 h/week	31 (1023)	41 (1464)	
2–3 h/week	24 (785)	30 (1083)	
> 3 h/week	45 (1494)	29 (1043)	
Sitting time			< 0.001
< 4.1 h/day	22 (730)	30 (1082)	
4.1–7.9 h/day	43 (1427)	43 (1548)	
> 7.9 h/day	35 (1145)	27 (960)	
Weight status			0.001
Normal weight or underweight	83 (2736)	86 (3090)	
Overweight	13 (432)	11 (387)	
Obese	4 (134)	3 (113)	
Smoking			< 0.001
Non-smoker	84 (2767)	80 (2857)	
0.1–1.0 pack-year	8 (274)	12 (445)	
> 1.0 pack-year	8 (261)	8 (288)	
Sleeping time			< 0.001
< 8 h/day	17 (552)	25 (891)	
8–9 h/day	66 (2198)	65 (2330)	
> 9 h/day	17 (552)	10 (369)	
Family SES			0.723
Higher clerical employees	7 (242)	6 (238)	
Self-employed	17 (568)	17 (615)	
Lower clerical employees	15 (493)	15 (531)	
Workers	40 (1315)	40 (1426)	
Students, pensioners, unemployed or unknown	21 (684)	22 (780)	

SES = socioeconomic status

Table 6. Distribution of psychosocial problems in problem and normal range among men and women (n = 6892).

Psychosocial problem	Men (n = 3302)		Women (n = 3590)	
	Problems range % (n)	Normal range % (n)	Problems range % (n)	Normal range % (n)
Internalizing problems				
Anxious/depressed[a]	3 (97)	97 (3205)	6 (200)	94 (3390)
Withdrawn/depressed[a]	7 (215)	93 (3087)	8 (268)	92 (3322)
Somatic complaints[a]	5 (164)	95 (3138)	15 (542)	85 (3048)
Externalizing problems				
Rule-breaking behaviour[a]	8 (278)	92 (3024)	15 (553)	85 (3037)
Aggressive behaviour[a]	7 (239)	93 (3063)	9 (312)	91 (3278)
Other problems				
Social problems[a]	3 (100)	97 (3202)	4 (153)	96 (3437)
Thought problems[a]	2 (51)	98 (3240)	4 (145)	96 (3433)
Attention problems[a]	3 (102)	97 (3199)	8 (272)	92 (3316)

[a] x^2 test: $p < 0.001$

Table 7. Fit statistics for one-class model through to seven-class model by gender.

Model	BIC	SSABIC	AIC	Entropy	LRT
Men					
1-Class model	38384.202	38346.073	38310.975	N/A	N/A
2-Class model	37902.138	37825.879	37755.683	0.811	0.1190
3-Class model	37609.967	37495.578	37390.284	0.784	0.3129
4-Class model	**37568.660**	37416.142	37275.750	0.644	**0.0008**
5-Class model	37603.055	37412.408	37236.918	**0.833**	< 0.001
6-Class model	37648.546	37419.770	37209.182	0.679	0.2307
7-Class model	37653.450	**37386.545**	**37140.859**	0.822	1.0000
Women					
1-Class model	26908.612	26870.482	26843.382	N/A	N/A
2-Class model	25935.439	25862.357	25793.163	0.654	**< 0.0001**
3-Class model	25917.237	25809.203	25706.917	0.634	0.0141
4-Class model	**25606.412**	25463.425	25328.046	0.804	0.0050
5-Class model	25641.632	25463.692	25295.221	0.707	0.4722
6-Class model	25669.709	**25456.817**	**25255.253**	0.762	0.6387
7-Class model	25766.152	25518.307	25283.651	**0.824**	0.1721

BIC = Bayesian Information Criteria, SSABIC = Sample Size-adjusted Bayesian Information Criteria, AIC = Akaike Information Criteria, LRT = p-value for the Lo-Mendell-Rubin Likelihood Ratio Test. The 'best' values are in bold. The 'second best' values are underlined.

high prevalence of physical inactivity (43%) and sitting time over eight hours (48%). The last cluster, Cluster 4, labelled the *Reference cluster* (prevalence rate 51%), included the participants with the most favourable characteristics, i.e. the likelihood of adequate sleeping time and exercising over three hours per week were the highest, and in contrast, the probabilities of internalizing (4%) and externalizing (0%) problems, long sitting time (13%), and smoking (6%) were the lowest. In addition, these participants had no weight problems (mean BMI 20.5.).

The women in Cluster 1 (*Externalizing behaviour*, prevalence rate 15%; Table 9) were likely to report internalizing (100%) and externalizing (36%) problems, but also to be physically active and exercise for over three hours per week (39%) and to smoke at a moderate level (32%). Twelve per cent of women were classified into the *Multiple risk behaviours cluster* which had the highest likelihood of internalizing problems (40%), exercising under two hours/week (73%), short sleeping time (53%), and smoking (81%). The women in this cluster also had a high likelihood of externalizing problems (80%), and their mean value of sitting time was the highest (9.5 hours). The obese participants were concentrated as a separate cluster of their own ('Obese', prevalence rate 7%). Their mean BMI was as high as 29.9. They were also relatively physically inactive (52%) and had a comparably long daily sitting time (mean value 7.3 hours). Participants in the *Reference cluster* (prevalence rate 66%) endorsed low levels of the unhealthy behaviours and psychosocial problems under study. In this subgroup, the women were likely to be of normal weight (mean BMI 20.5), sleep sufficiently (72%), not smoke (93%) and have no internalizing (12%) or externalizing (0%) problems. The average sitting time was considerably short (5.9) and the probability of being physically active was considerably high (32%).

With respect to the psychosocial subscales of internalizing and externalizing problems (Tables 10 and 11), somatic complaints were the most represented category of internalizing problems among all the clusters' women and among the Externalizing behaviour cluster men. Among the other clusters' men, withdrawn/depressed symptoms had the highest prevalence rates. In terms of externalizing problems, rule-breaking behaviour was slightly more prevalent than aggressive behaviour across the clusters.

Table 8. Prevalence rates and proportions or mean values of psychosocial problems and unhealthy behaviours among the four clusters' men (n = 3302).

Variable	Externalizing behaviour (n = 473)	Sedentary (n = 886)	Obese (n = 258)	Reference (n = 1685)
Internalizing problems[a]				
Problem range (%)	31	15	12	4
Normal range (%)	69	85	88	96
Externalizing problems[a]				
Problem range (%)	100	0	20	0
Normal range (%)	0	100	80	100
Physical activity[a]				
< 2 h/week (%)	34	50	43	18
2–3 h/week (%)	19	30	29	21
> 3 h/week (%)	48	20	28	60
Sitting time[a,b]				
< 4.1 h/day (%)	17	7	14	33
4.1–7.9 h/day (%)	43	25	37	54
> 7.9 h/day (%)	41	68	48	13
Sleeping time[a]				
< 8 h/day (%)	27	39	25	1
8–9 h/day (%)	54	47	60	82
> 9 h/day (%)	19	15	15	17
BMI[a,b]				
mean value (CI), kg/m^2	20.6 (20.4–20.9)	20.1 (20.0–20.3)	29.7 (29.3–30.2)	20.5 (20.4–20.6)
Smoking[a]				
non-smoker (%)	54	79	86	94
0.1–1.0 pack-years (%)	23	9	7	4
> 1.0 pack-years (%)	23	12	7	2

[a]x^2 test: $p < 0.001$, [b]Continuous variables used; CI = confidence interval, BMI = body mass index

Table 9. Prevalence rates and proportions or mean values of psychosocial problems and unhealthy behaviours among the four clusters' women (n = 3590).

Variable	Externalizing behaviour (n = 539)	Multiple risk behaviours (n = 425)	Obese (n = 239)	Reference (n = 2387)
Internalizing problems[a]				
Problem range (%)	36	40	18	12
Normal range (%)	64	60	82	88
Externalizing problems[a]				
Problem range (%)	100	80	22	0
Normal range (%)	0	20	78	100
Physical activity[a]				
< 2 h/week (%)	31	73	52	36
2–3 h/week (%)	30	19	30	32
> 3 h/week (%)	39	8	18	32
Sitting time[a,b]				
mean value (CI), h/day	5.4 (5.2–5.6)	9.5 (9.1–9.9)	7.3 (6.8–7.8)	5.9 (5.7–6.0)
Sleeping time[a]				
< 8 h/day (%)	24	53	30	20
8–9 h/day (%)	65	32	55	72
> 9 h/day (%)	11	15	16	9
BMI[a,b]				
mean value (CI), kg/m^2	20.6 (20.4–20.8)	20.9 (20.7–21.2)	29.9 (29.4–30.5)	20.5 (20.4–20.6)
Smoking[a]				
non-smoker (%)	68	19	80	93
0.1–1.0 pack-years (%)	29	26	13	6
> 1.0 pack-years (%)	3	55	8	1

[a]x^2 test: $p < 0.001$, [b]Continuous variables used; CI = confidence interval, BMI = body mass index

Table 10. Distribution of psychosocial problems in problem and normal range among clusters' men (n = 3302).

Psychosocial problem	Externalizing behaviour		Sedentary		Obese		Reference	
	Problems range % (n)	Normal range % (n)	Problems range % (n)	Normal range % (n)	Problems range % (n)	Normal range % (n)	Problems range % (n)	Normal range % (n)
Internalizing problems								
Anxious/depressed[a]	8 (38)	92 (435)	4 (33)	96 (853)	4 (11)	96 (247)	1 (15)	99 (1670)
Withdrawn/depressed[a]	12 (56)	88 (417)	9 (83)	91 (803)	8 (21)	92 (237)	3 (55)	97 (1630)
Somatic complaints[a]	15 (72)	85 (401)	4 (33)	96 (853)	6 (15)	94 (243)	3 (44)	97 (1641)
Externalizing problems								
Rule-breaking behaviour[a]	48 (226)	52 (247)	2 (19)	98 (867)	6 (16)	94 (232)	1 (7)	99 (1678)
Aggressive behaviour[a]	43 (203)	57 (270)	1 (5)	99 (881)	11 (29)	89 (229)	1 (2)	99 (1683)
Other problems								
Social problems[a]	7 (35)	93 (438)	4 (35)	96 (851)	6 (15)	94 (243)	1 (15)	99 (1670)
Thought problems[a]	6 (28)	94 (440)	2 (13)	98 (872)	2 (5)	98 (252)	1 (5)	99 (1676)
Attention problems[a]	13 (63)	87 (409)	2 (16)	98 (870)	3 (11)	97 (247)	1 (12)	99 (1673)

[a] x^2 test: $p < 0.001$

Table 11. Distribution of psychosocial problems in problem and normal range among clusters' women (n = 3590).

Psychosocial problem	Externalizing behaviour		Multiple risk behaviours		Obese		Reference	
	Problems range % (n)	Normal range % (n)	Problems range % (n)	Normal range % (n)	Problems range % (n)	Normal range % (n)	Problems range % (n)	Normal range % (n)
Internalizing problems								
Anxious/depressed[a]	13 (68)	87 (471)	13 (55)	87 (370)	3 (7)	97 (232)	3 (70)	97 (2317)
Withdrawn/depressed[a]	13 (71)	87 (468)	16 (68)	84 (357)	8 (18)	92 (221)	5 (111)	95 (2276)
Somatic complaints[a]	29 (158)	71 (381)	36 (152)	64 (273)	15 (35)	85 (204)	8 (197)	92 (2190)
Externalizing problems								
Rule-breaking behaviour[a]	44 (235)	56 (304)	61 (258)	39 (167)	11 (27)	89 (212)	1 (33)	99 (2354)
Aggressive behaviour[a]	31 (169)	69 (370)	29 (124)	71 (301)	8 (18)	92 (221)	1 (1)	99 (2386)
Other problems								
Social problems[a]	7 (40)	93 (499)	11 (48)	89 (377)	5 (13)	95 (226)	2 (52)	98 (2335)
Thought problems[a]	12 (63)	88 (473)	13 (54)	87 (370)	3 (8)	97 (231)	1 (20)	99 (2359)
Attention problems[a]	18 (98)	82 (441)	24 (104)	76 (321)	4 (10)	96 (228)	3 (60)	97 (2326)

[a] x^2 test: $p < 0.001$

5.3.3 Prevalence of unhealthy behaviours at 16 and 18 years in clusters

The prevalence of smoking, physical inactivity and overweight (BMI 25 or over) were estimated at 16 and 18 years among the OBS participants (n = 1552). Among the men in the Externalizing behaviour cluster (Fig. 6), all unhealthy behaviours were more prevalent at 18 years than at 16 years, the prevalence rates being 29% and 40% for physical inactivity, 11% and 19% for overweight, and 42% and 57% for smoking, respectively. In the Sedentary cluster, over half of the men were physically inactive, only 7% of participants were overweight, and 24% smoked at baseline. During the follow-up, the proportion of physically inactive men slightly decreased (48%), while the prevalence of smoking slightly increased (32%). Seven per cent of the men were also overweight at follow-up. In the Obese cluster, an excessively high prevalence of overweight (100%) was observed and over half were physically inactive, but only 12% reported smoking. The proportion of smokers was higher at 18 years than at 16 (32%), but physical inactivity and overweight were slightly less prevalent (89% and 46%, respectively), although still at a high level. In the Reference cluster, all the adverse behaviours were uncommon at baseline and follow-up. The proportion of smokers increased between the measured time points but was still at a low level (5% and 18%, respectively).

Of the women in the Externalizing behaviour cluster, nearly one third was physically inactive and smoked, and only 7% were overweight at baseline (Fig. 7). At 18 years, the prevalence rates were quite similar to those at baseline. In the Multiple risk behaviours cluster, the frequencies of physical inactivity and smoking were at the highest levels at 16 years and remained at significant levels at follow-up (66%; 78% and 74%, respectively). Overweight was uncommon (11% at 16 and 10% at 18). In the Obese cluster, overweight was highly prevalent (100%), a half reported less than two hours of PA (56%), and only 9% of participants smoked. Smoking was more common (32%), overweight slightly less prevalent (85%), and inactivity had similar rates (53%) at 18 years and 16 years. In the Reference cluster, a third was inactive and only a few were overweight at baseline and follow-up. Almost none smoked at 16 (7%), although the number of smokers increased between the ages of 16 and 18, their proportion remaining low nevertheless (19%).

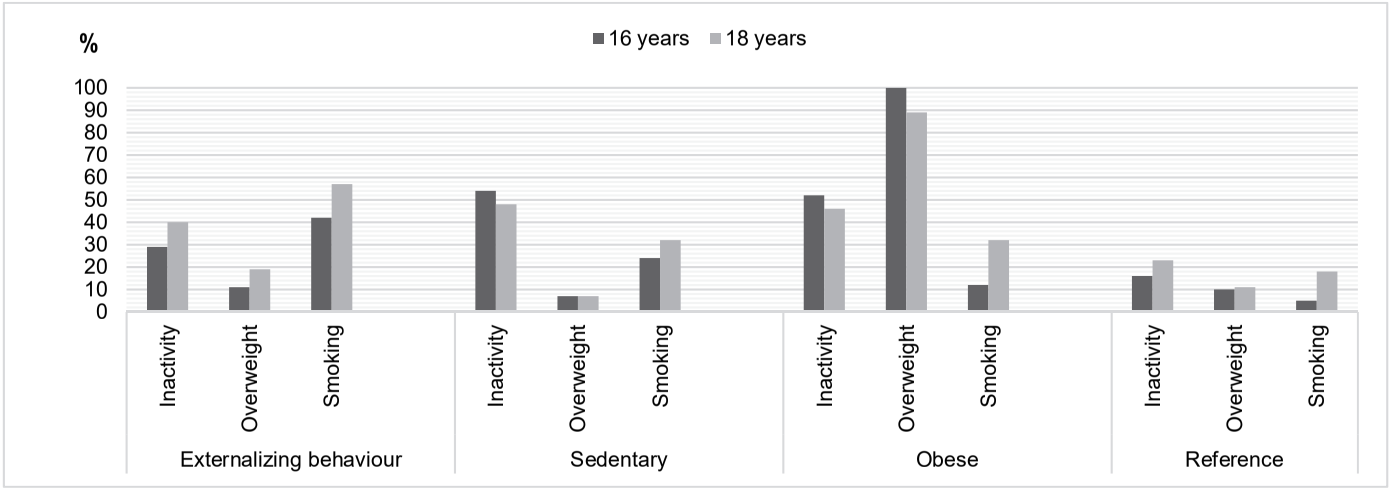

Fig. 6. Prevalence of smoking, physical inactivity and overweight among Oulu Back Study cluster men at 16 and 18 years (n = 681).

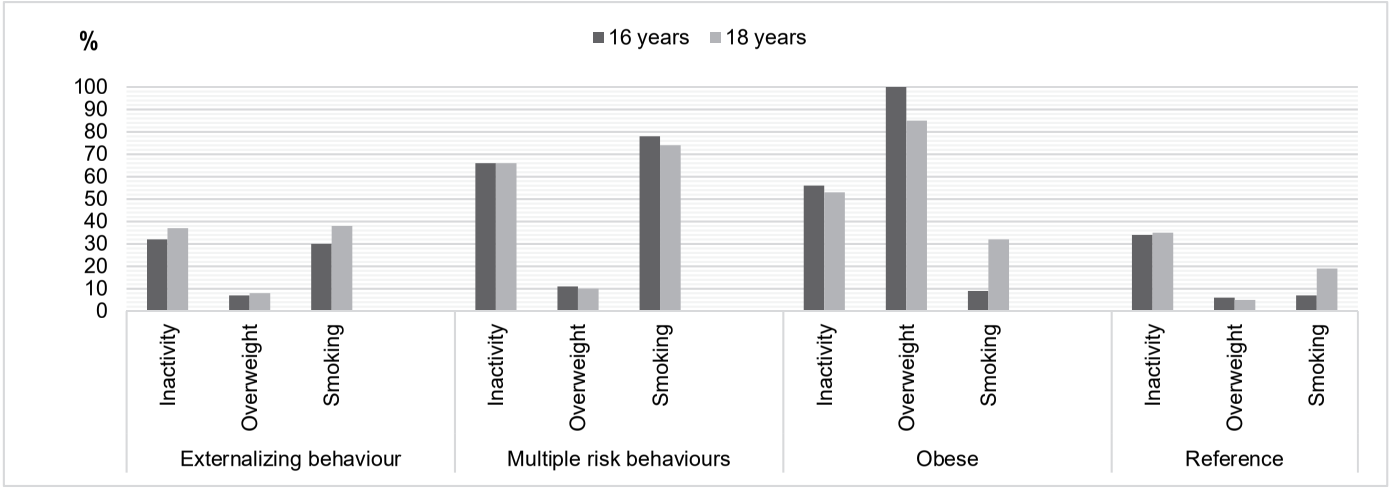

Fig. 7. Prevalence of smoking, physical inactivity and overweight among Oulu Back Study cluster women at 16 and 18 years (n = 871).

5.4 Low back pain (Study II)

5.4.1 Prevalence

The prevalence of LBP was higher at 18 than 16 years among both genders, and more women than men suffered from LBP at baseline and follow-up (49% vs 36% at 16; 63% vs 47% at 18; Table 12). At 16 years, 31% of the men and 44% of the women reported pain, whereas only 5% of both men and women had consulted a health care professional due to LBP. The percentages of 'Reporting LBP' were higher at follow-up (42% among the men and 57% among the women) than at baseline, but the consultation rate remained at a low level (5% for men and 6% for women).

Across the clusters (n = 6812; Fig. 8), the Externalizing behaviour cluster men and the Multiple risk behaviours cluster women showed the highest prevalence rates of LBP at 16 (50% and 63%, respectively) and 18 years (60% and 74%, respectively), whereas the Reference cluster participants had the least LBP problems (32% at 16 and 45% at 18 for men; and 44% and 60% for women). Of the LBP categories at baseline and follow-up, 'Reporting LBP' was the most frequent among both the Externalizing behaviour cluster men (43% and 55%, respectively) and women (55% and 64%, respectively), whereas the Multiple risk behaviours cluster women had most often sought care for LBP at both time points (10% and 12%).

Of the men who had no LBP at 16 years, 39% of the Externalizing behaviour, 37% of the Sedentary, 19% of the Obese, and 36% of the Reference clusters' participants reported LBP at 18 years (Fig. 9). Among the women (Fig. 10), the respective figures were 63% in the Externalizing behaviour, 62% in the Multiple risk behaviour, 54% in the Obese, and 48% in the Reference cluster. Most of the complaints were 'Reporting LBP' among both genders, and the rates of consultation for LBP were subsequently low, except among the Externalizing behaviour cluster's women (13%).

Table 12. Low back pain (LBP) characteristics of cluster adolescents at 16 years (baseline data, n = 6812) and 18 years (OBS data, n = 1625).

LBP	Men % (n)	Women % (n)	P-value (x2)
LBP at 16			< 0.001
No pain	64 (2089)	51 (1799)	
Reporting LBP	31 (1022)	44 (1567)	
Consultation for LBP	5 (145)	5 (190)	
LBP at 18			< 0.001
No pain	53 (374)	37 (336)	
Reporting LBP	42 (298)	57 (520)	
Consultation for LBP	5 (40)	6 (57)	

OBS = Oulu Back Study

5.4.2 Associations between latent class clusters and low back pain

Cross-sectional associations

Among the women, belonging to the Multiple risk behaviours (RR 2.50, CI 1.77–3.52), Externalizing behaviour (RR 1.56, CI 1.07–2.28) and Obese (RR 1.68, CI 1.01–2.80) clusters associated with 'Consultation for LBP' at 16 years (Table 13). The women in the Multiple risk behaviours and Externalizing behaviour clusters were more likely to report 'Reporting LBP' (RR 1.32, CI 1.19–1.47; RR 1.37, CI 1.25–1.50). Among the men, only those in the Externalizing behaviour cluster were more likely to report 'Consultation for LBP' (RR 1.60, CI 1.07–2.40) and 'Reporting LBP' (RR 1.53, CI 1.34–1.74) than those in the Reference cluster.

Longitudinal associations

Externalizing behaviour cluster women were at an increased risk of new onset of 'Consultation LBP' at 18 years (RR 3.62, CI 1.54–8.50; Table 13). New onset of 'Reporting LBP' did not associate with the clusters among the women. No significant association was found between the clusters and new onset of 'Reporting LBP' or 'Consultation for LBP' among the men.

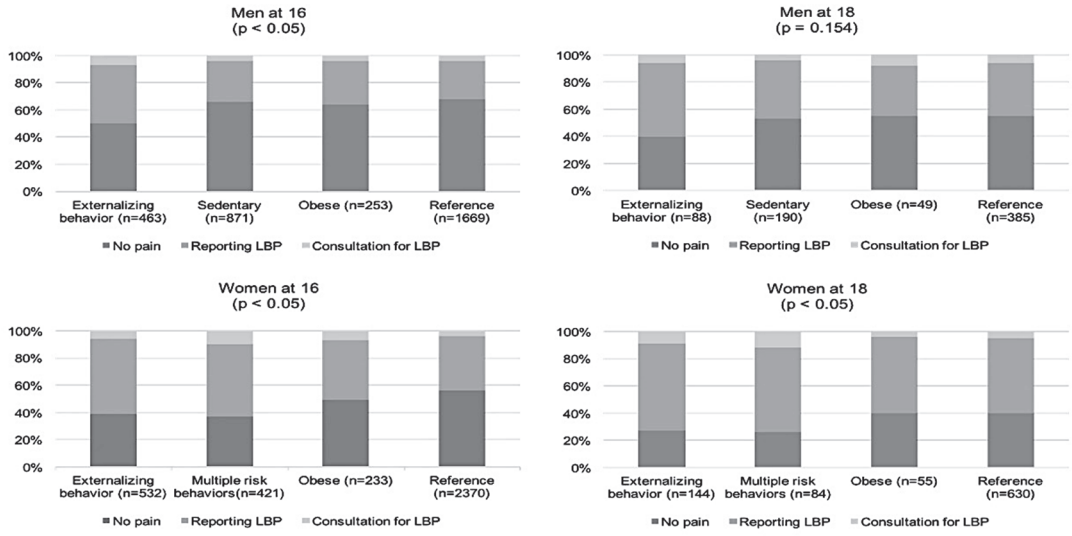

Fig. 8. Prevalence of LBP in clusters at 16 (n = 3256 for men, n = 3556 for women) and 18 years (n = 712 for men, n = 912 for women), both genders.

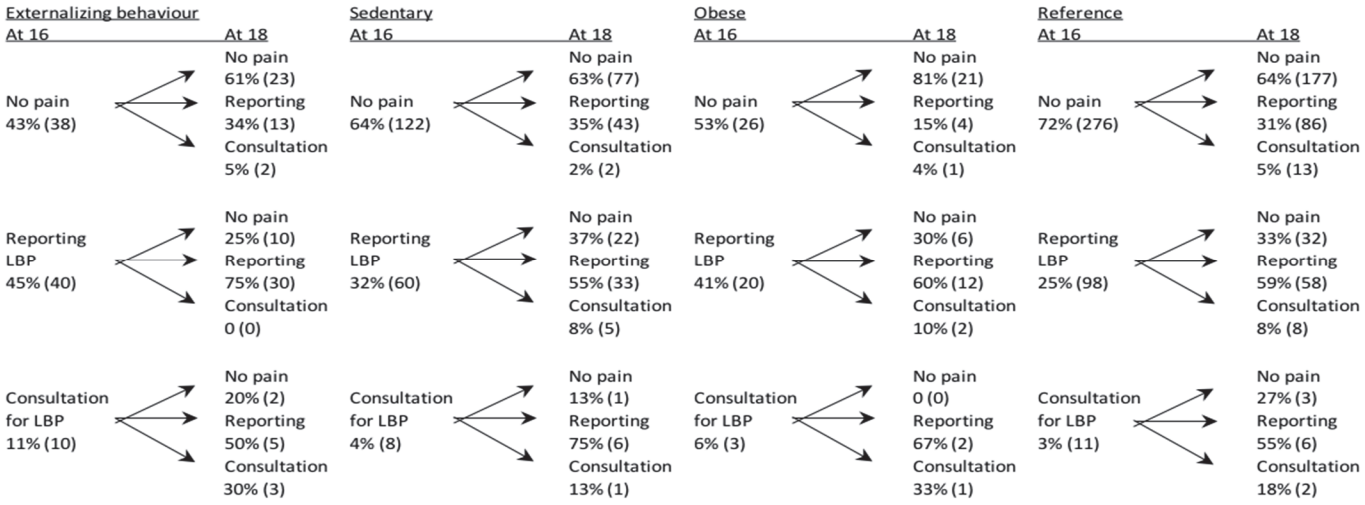

Fig. 9. Distributions of LBP, reporting and consultation for LBP between ages of 16 (n = 3256) and 18 (n = 712) among clusters' men, % (n).

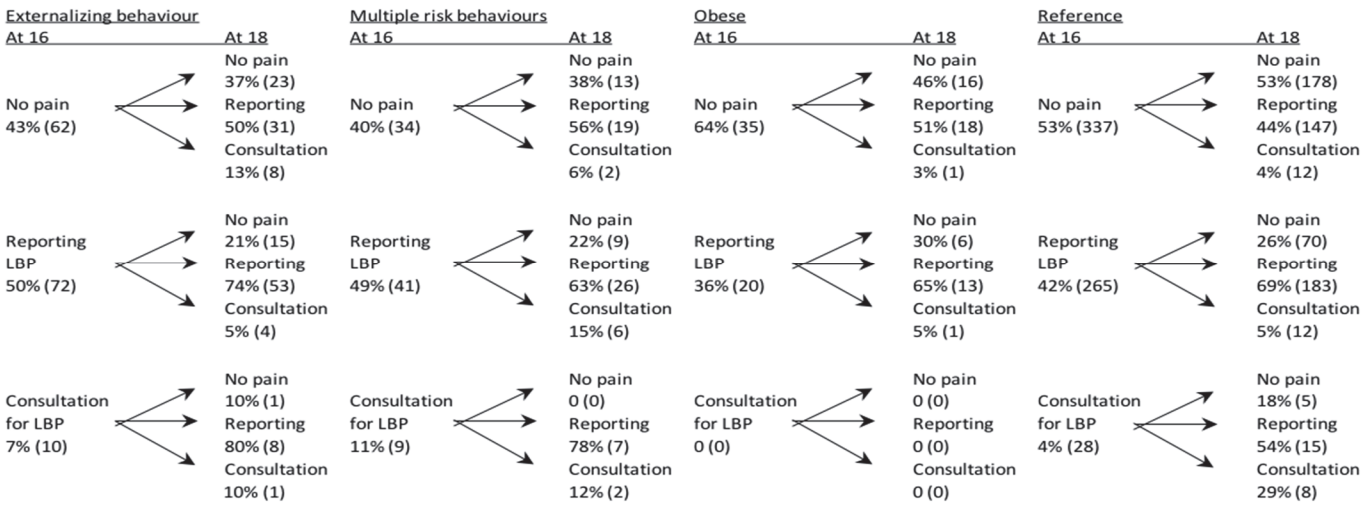

Fig. 10. Distributions of no LBP, reporting and consultation for LBP between ages of 16 (n = 3556) and 18 (n = 912) among clusters' women, % (n).

Table 13. Risk ratios (RRs) and confidence intervals (CIs) for associations between both genders of clusters and LBP at 16 years and new onset of LBP between the ages of 16 and 18.

Clusters	Reporting LBP at 16	Consultation for LBP at 16	No pain at 16	New onset of Reporting LBP	New onset of Consultation LBP	No LPB at 16 and 18
Men						
Externalizing behaviour	**1.53** (1.34–1.74)	**1.60** (1.07–2.40)	1.0	1.10 (0.68–1.76)	1.12 (0.26–4.76)	1.0
Sedentary	1.08 (0.95–1.22)	0.85 (0.57–1.28)	1.0	1.13 (0.84–1.52)	0.35 (0.08–1.52)	1.0
Obese	1.13 (0.93–1.37)	0.82 (0.42–1.63)	1.0	0.49 (0.20–1.24)	0.82 (0.11–6.00)	1.0
Reference	1.0	1.0		1.0	1.0	
Women						
Externalizing behaviour	**1.37** (1.25–1.50)	**1.56** (1.07–2.28)	1.0	1.15 (0.87–1.51)	**3.62** (1.54–8.50)	1.0
Multiple risk behaviours	**1.32** (1.19–1.47)	**2.50** (1.77–3.52)	1.0	1.28 (0.93–1.77)	1.65 (0.39–7.08)	1.0
Obese	1.10 (0.95–1.29)	**1.68** (1.01–2.80)	1.0	1.18 (0.84–1.66)	0.80 (0.11–5.99)	1.0
Reference	1.0	1.0		1.0	1.0	

Adjusted for family SES. Statistically significant values are in bold. New onset = no LBP at 16, but at 18, consultation for LBP = participants consulted a health care professional due to LBP; n = 6812 for cross-sectional analyses, n = 1625 for longitudinal analyses

5.5 Multisite musculoskeletal pain (Study III)

5.5.1 Prevalence

Forty-two per cent of the men and 63% of the women at baseline, and 57% of the men and 81% of the women at follow-up had two or more pain sites (Table 14). More women reported three or four pain sites at 18 than at 16 years (60% vs. 39%).

Across the clusters, MMSP was the most prevalent among the Externalizing behaviour cluster men and among the Multiple risk behaviours cluster women at 16 (61% and 78%, respectively) and 18 years (68% and 89%, respectively; Tables 15 and 16). The Externalizing behaviour cluster women also had a high prevalence of MMSP at both time points (77% and 87%), and a significant number of the Obese (55% for the men; 82% for the women) and Sedentary cluster participants (63%), and the Reference cluster women (78%) also reported MMSP at 18 years. The most reported pains among the men were two-site pain in the Externalizing behaviour (22%) and Obese (28%) clusters, and one-site pain in the Sedentary (23%) and Reference (27%) clusters at 16 years. At 18 years, two-site pain was also the most frequently reported in the Externalizing behaviour (27%) and Obese (23%) clusters, whereas reporting three-site pain was the most prevalent in the Sedentary cluster (25%). One-site pain had the highest prevalence rate in the Reference subgroup (25%). Among the women, four-site pain was the most common in the Multiple risk behaviours cluster (28%), three-site pain in the Externalizing behaviour cluster (29%), and two-site pain in the Obese (27%) and Reference (24%) clusters at baseline. At follow-up, four-site pain was the most prevalent among the participants of the Externalizing behaviour cluster (39%), and three-site pain among the participants of the Multiple risk behaviours (43%), Obese (35%), and Reference (33%) clusters. In general, the frequency of MMSP increased between the ages of 16 and 18 years in each cluster.

Having no MMSP at baseline and follow-up was uncommon in each cluster among both genders (Fig. 11 and 12). MMSP occurred at 16 and 18 years among 52%, 36%, 38%, and 26% of the men belonging to the Externalizing behaviour, Sedentary, Obese and Reference cluster, respectively at 16 years, and among 70%, 71%, 51%, and 51% of the women belonging to the Externalizing behaviour, Multiple risk behaviours, Obese, and Reference cluster, respectively at baseline.

Table 14. Multisite musculoskeletal pain (MMSP) characteristics of cluster adolescents at 16 years (n = 6749) and 18 years (OBS data, n = 1583).

Multisite musculoskeletal pain	Men % (n)	Women % (n)	P-value (x2)
MMSP at 16*			< 0.001
No pain	32 (1042)	17 (595)	
One-site pain	25 (796)	19 (675)	
Two-site pain	20 (660)	24 (854)	
Three-site pain	13 (434)	23 (824)	
Four-site pain	9 (291)	16 (578)	
MMSP at 18*			< 0.001
No pain	23 (162)	8 (69)	
One-site pain	19 (133)	11 (100)	
Two-site pain	24 (167)	21 (185)	
Three-site pain	19 (130)	33 (298)	
Four-site pain	14 (99)	27 (240)	

OBS = Oulu Back Study

Table 15. Number of musculoskeletal pains in clusters at 16 (n = 3223) and 18 (n = 691) years among men.

Number of musculoskeletal pains	Externalizing behaviour % (n)	Sedentary % (n)	Obese % (n)	Reference % (n)
Pain site at 16[a]				
No pain	19 (88)	34 (294)	28 (70)	36 (590)
One-site pain	20 (93)	23 (200)	25 (62)	27 (441)
Two-site pain	22 (98)	21 (181)	28 (71)	19 (310)
Three-site pain	22 (98)	13 (108)	11 (28)	12 (200)
Four-site pain	17 (79)	9 (80)	9 (20)	7 (112)
Pain site at 18[b]				
No pain	17 (14)	22 (41)	25 (12)	25 (95)
One-site pain	15 (13)	14 (26)	21 (10)	22 (84)
Two-site pain	27 (23)	23 (43)	23 (11)	24 (90)
Three-site pain	17 (14)	25 (46)	15 (7)	17 (63)
Four-site pain	24 (20)	15 (28)	17 (8)	12 (43)

[a] x^2 test: $p < 0.05$, [b] x^2 test: $p = 0.053$

Table 16. Number of musculoskeletal pains in clusters at 16 (n = 3526) and 18 (n= 892) years among women.

Number of musculoskeletal pains	Externalizing behaviour % (n)	Multiple risk behaviours % (n)	Obese % (n)	Reference % (n)
Pain site at 16				
No pain	8 (44)	8 (31)	13 (30)	21 (490)
One-site pain	15 (80)	15 (62)	20 (46)	21 (487)
Two-site pain	24 (128)	23 (95)	27 (62)	24 (569)
Three-site pain	29 (151)	27 (111)	23 (53)	22 (509)
Four-site pain	24 (125)	28 (117)	17 (40)	13 (296)
Pain site at 18				
No pain	7 (10)	3 (2)	6 (3)	9 (54)
One-site pain	6 (8)	9 (7)	13 (7)	13 (78)
Two-site pain	20 (28)	13 (10)	27 (15)	21 (132)
Three-site pain	29 (41)	43 (34)	35 (19)	33 (204)
Four-site pain	39 (55)	33 (26)	20 (11)	24 (148)

x^2 test: $p < 0.05$ for all analyses

5.5.2 Associations between latent class clusters and recurrent multisite musculoskeletal pain in two-year follow-up

Belonging to the Externalizing behaviour cluster at 16 years associated significantly with having MMSP at 16 and 18 years among both the men (OR 2.98, CI 1.73–5.13) and the women (OR 2.38, CI 1.38–4.11; Fig. 13). In addition, significant relations between the Multiple risk behaviours and Sedentary clusters and recurrent MMSP were observed (OR 2.73, CI 1.30–5.71; OR 1.85, CI 1.21–2.82). The Obese clusters did not relate to recurrent MMSP among either the men or women.

	At 18 years							
At 16 years	No pain or one-site pain	Two or more pain sites	No pain or one-site pain	Two or more pain sites	No pain or one-site pain	Two or more pain sites	No pain or one-site pain	Two or more pain sites
No pain or one-site pain	20% (n = 17)	15% (n = 13)	25% (n = 46)	27% (n = 50)	31% (n = 15)	17% (n = 8)	**37% (n = 140)**	27% (n = 100)
Two or more pain sites	12% (n = 10)	**52% (n = 44)**	11% (n = 21)	**36% (n = 67)**	14% (n = 7)	**38% (n = 18)**	10% (n = 39)	26% (n = 96)
	Externalizing behaviour ($p < 0.001$)		**Sedentary** ($p < 0.001$)		**Obese** ($p < 0.001$)		**Reference** ($p < 0.001$)	

Fig. 11. Proportions of different MMSP groups between ages of 16 and 18 among clusters' men (n = 691). Dark boxes contain the most prevalent pain phenomenon in each cluster.

	At 18 years							
At 16 years	No pain or one-site pain	Two or more pain sites	No pain or one-site pain	Two or more pain sites	No pain or one-site pain	Two or more pain sites	No pain or one-site pain	Two or more pain sites
No pain or one-site pain	5% (n = 7)	18% (n = 25)	6% (n = 5)	18% (n = 14)	11% (n = 6)	31% (n = 17)	13% (n = 83)	28% (n = 171)
Two or more pain sites	8% (n = 11)	70% (n = 99)	5% (n = 4)	71% (n = 56)	7% (n = 4)	51% (n = 28)	8% (n = 49)	51% (n = 313)
	Externalizing behaviour ($p < 0.001$)		**Multiple risk behaviours** ($p < 0.001$)		**Obese** ($p < 0.001$)		**Reference** ($p < 0.001$)	

Fig. 12. Proportions of different MMSP groups between ages of 16 and 18 among clusters' women (n = 892). Dark boxes contain the most prevalent pain phenomenon in each cluster.

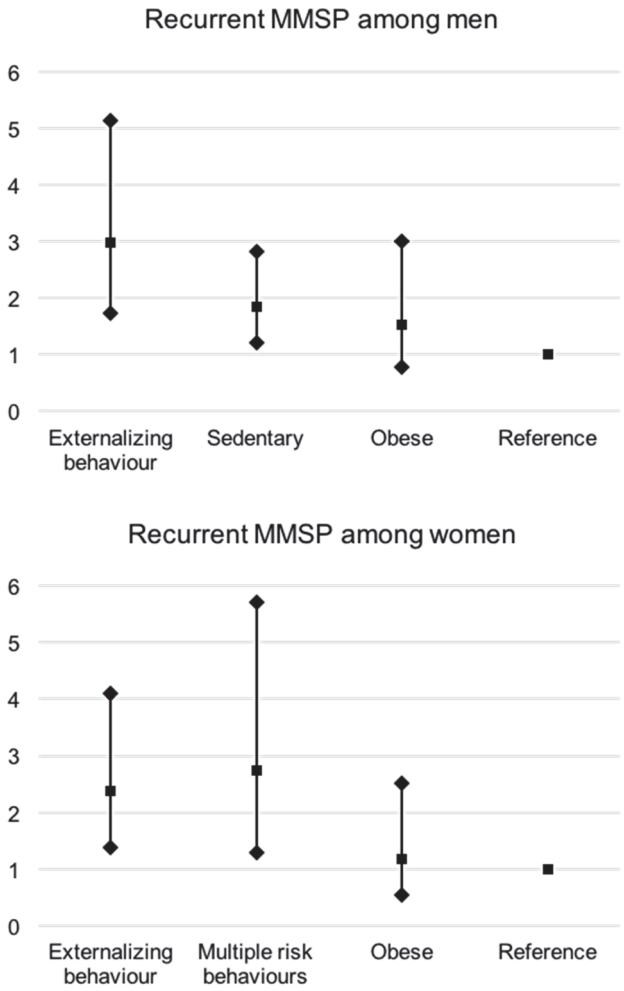

Fig. 13. Odds ratios and their confidence intervals for associations between recurrence of MMSP and clusters at follow-up among men (n = 691) and women (n = 892). Analyses were adjusted for family SES, and no pain or one-site pain at 16 and 18 years was used as reference.

5.6 Labour market inclusion (Study IV)

5.6.1 Prevalence of unemployment, employment, permanent work disability, parental leave, and education

Slightly over half of the women and men of the study population had no unemployment days between the ages of 25 and 29 years (Table 17). One fourth had been unemployed for less than one year and one-tenth for one to two years among both genders. Unemployment days of three to four years had accumulated among 4% of the men and 3% of the women, and of four to five years among 2% of the men and 1% of the women. In contrast, 63% of the men and 50% of the women recorded employment days of over four years during the five-year follow-up. Employment days of three to four years, two to three years, one to two years, and under one year had accumulated among 13%, 8%, 6%, and 6% of the men and among 14%, 12%, 10%, and 8% of the women, respectively. Five per cent of both the men and women had no employment days. One per cent had received disability pension or rehabilitation benefits. More of the women than the men had a tertiary degree education (53% vs 37%) and had been on parental leave for at least a day (48% vs 27%).

Among the women, unemployment was the most prevalent in the Multiple risk behaviours cluster and least common in the Reference cluster (Table 18). Of the Multiple risk behaviours and the Reference cluster women, 36% and 19% had been unemployed for over one year, respectively. Among the men, the prevalence of unemployment was lower in the Reference cluster than in the other clusters (17% for over one year of unemployment), but no significant differences were observed between the other three clusters, as the percentages for over one year of unemployment were 24% for the Sedentary, 27% for the Externalizing behaviour, and 28% for the Obese clusters. The highest prevalence rates of no unemployment were seen among both genders in the Reference cluster (59% and 52%; $p < 0.001$). With respect to employment days (Table 19), a slightly larger proportion of the men in the Reference cluster had been employed for more than four years than the other clusters' men, but among the women, there were no relevant differences between the clusters' distribution of employment days. The frequency of permanent work disability varied from 1% to 2% across the clusters (Table 20). A significantly lower proportion of both genders in the Obese cluster had been on parental leave ($p < 0.05$) than in the other clusters. Regarding education level, the Externalizing behaviour cluster men and the Multiple risk behaviours cluster women had the

highest prevalence of compulsory education (14% and 11%, respectively, $p < 0.05$). Having a tertiary degree was the most prevalent in the Reference clusters among both genders (44% among the men and 60% among the women).

Table 17. Demographic characteristics of unemployment, employment, permanent work disability, parental leave, and education level during five-year follow-up among clusters' men and women.

Variable	Men % (n)	Women % (n)	P-value (x2)
Unemployment[a]			< 0.001
No unemployment	55 (1770)	51 (1791)	
Under one year	24 (777)	28 (980)	
1 to 2 years	9 (292)	11 (393)	
2 to 3 years	6 (181)	7 (235)	
3 to 4 years	4 (127)	3 (106)	
4 to 5 years	2 (78)	1 (39)	
Employment[a]			< 0.001
No employment	5 (149)	5 (187)	
Under one year	6 (197)	8 (294)	
1 to 2 years	6 (202)	10 (344)	
2 to 3 years	8 (241)	12 (430)	
3 to 4 years	13 (412)	14 (512)	
4 to 5 years	63 (2024)	50 (1777)	
Parental leave[b]			< 0.001
Yes	27 (884)	48 (1729)	
No	73 (2375)	52 (1847)	
Permanent work disability[b]			0.531
Yes	1 (34)	1 (32)	
No	99 (3225)	99 (3544)	
Education level[b]			< 0.001
Compulsory	8 (248)	4 (136)	
Secondary	56 (1808)	43 (1552)	
Tertiary	37 (1203)	53 (1888)	

[a] Cluster participants with disability days (n = 66) are not included, n = 6769; [b] n = 6835

Table 18. Prevalence rates of cumulative unemployment days across five-year follow-up in clusters.

Unemployment	Men (n = 3225)				Women (n = 3544)			
	Externalizing behaviour % (n)	Sedentary % (n)	Obese % (n)	Reference % (n)	Externalizing behaviour % (n)	Multiple risk behaviours % (n)	Obese % (n)	Reference % (n)
No unemployment days	49 (219)	50 (437)	53 (135)	59 (979)	51 (271)	43 (180)	49 (117)	52 (1223)
Under one year	24 (106)	26 (225)	19 (48)	24 (398)	26 (137)	21 (85)	22 (52)	30 (706)
One to two years	11 (51)	9 (78)	11 (29)	8 (134)	12 (67)	15 (62)	12 (29)	10 (235)
Two to three years	7 (32)	6 (48)	6 (16)	5 (85)	7 (35)	13 (53)	10 (24)	5 (123)
Three to four years	5 (21)	6 (48)	6 (14)	3 (44)	3 (14)	6 (26)	5 (12)	3 (54)
Four to five years	4 (19)	3 (28)	5 (12)	1 (19)	1 (6)	2 (7)	2 (4)	1 (22)

x^2 test: $p < 0.05$ for both genders

Table 19. Prevalence rates of cumulative employment days across five-year follow-up in clusters.

Employment	Men (n = 3225)				Women (n = 3544)			
	Externalizing behaviour % (n)	Sedentary % (n)	Obese % (n)	Reference % (n)	Externalizing behaviour % (n)	Multiple risk behaviours % (n)	Obese % (n)	Reference % (n)
No employment days	5 (25)	6 (54)	7 (19)	3 (51)	5 (25)	8 (34)	8 (19)	5 (109)
Under one year	8 (36)	7 (61)	9 (22)	5 (78)	9 (46)	11 (44)	8 (19)	8 (185)
One to two years	7 (32)	7 (63)	6 (15)	6 (92)	11 (57)	11 (47)	9 (21)	9 (219)
Two to three years	8 (35)	7 (57)	7 (17)	8 (132)	10 (54)	12 (48)	14 (34)	12 (294)
Three to four years	13 (57)	12 (105)	12 (30)	13 (220)	13 (72)	13 (55)	12 (28)	15 (357)
Four to five years	59 (263)	61 (524)	59 (151)	65 (1086)	52 (276)	45 (185)	49 (117)	51 (1199)

x^2 test: $p < 0.05$ for both genders

Table 20. Prevalence rates of permanent work disability, parental leave and education level in clusters among men (n = 3259) and women (n = 3576).

Clusters	Permanent work disability		Parental leave		Education level		
	Yes	No	Yes	No	Compulsory	Secondary	Tertiary
	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)
Men							
Externalizing behaviour	2 (11)	98 (448)	26 (120)	74 (339)	14 (64)	63 (289)	23 (106)
Sedentary	1 (7)	99 (864)	24 (206)	76 (665)	8 (65)	59 (516)	33 (290)
Obese	2 (4)	98 (254)	20 (51)	80 (207)	9 (22)	62 (160)	30 (76)
Reference	1 (12)	99 (1659)	30 (507)	70 (1164)	6 (97)	50 (843)	44 (731)
Women							
Externalizing behaviour	2 (8)	98 (530)	48 (257)	52 (281)	4 (22)	45 (244)	51 (272)
Multiple risk behaviours	2 (8)	98 (413)	55 (231)	45 (190)	11 (45)	66 (276)	24 (100)
Obese	1 (1)	99 (238)	43 (102)	57 (137)	6 (15)	57 (136)	37 (88)
Reference	1 (15)	99 (2363)	48 (1139)	52 (1239)	2 (54)	38 (896)	60 (1428)

x^2 test: $p < 0.05$ for both genders

5.6.2 Associations between latent class clusters and cumulative unemployment, employment days and permanent work disability between ages of 25 and 29

In comparison to the Reference cluster, belonging to the Externalizing behaviour (RR 1.64, CI 1.25–2.14), Sedentary (RR 1.41, CI 1.13–1.75), and Obese (RR 1.50, CI 1.08–2.09) clusters increased the risk of unemployment of over one year among the men (Fig. 14). In addition, being part of the Sedentary cluster related to under one year of unemployment (RR 1.25, CI 1.02–1.52). Multiple risk behaviours (RR 1.77, CI 1.37–2.28) cluster women were more likely to be unemployed for over a year than the women in the Reference cluster (Fig. 15).

With respect to employment days, belonging to the Sedentary (RR 1.93, CI 1.26–2.95) and Obese (RR 1.93, CI 1.07–3.50) clusters was associated with having no employment days among the men (Fig. 16). No significant relationships between the clusters and employment days were found among the women (Fig. 17).

The men in the Externalizing behaviour cluster (OR 2.49, CI 1.07–5.78) were at an increased risk of permanent work disability during the follow-up period in comparison to those in the Reference cluster (Fig. 18). All previous analyses were adjusted for education, parental leave, and family SES.

5.6.3 Influence of multisite musculoskeletal pain on associations between latent class clusters, unemployment, employment, and permanent work disability

To study the role of MMSP in the relationships between clusters and labour market outcomes, the impact of MMSP on labour market outcomes was evaluated. In the analyses, no significant associations between reported MMSP at 16 years and register-based unemployment, employment, or permanent work disability over five years from the ages of 25 to 29 were observed (Table 21). Secondly, MMSP was added to the logistic regression analysis models of clusters and the labour market outcomes, and an interaction term of LCA clusters and MMSP was formed and included in the analyses. The p-values of the interaction terms were high, emphasizing that MMSPs did not play an independent role in the outcomes.

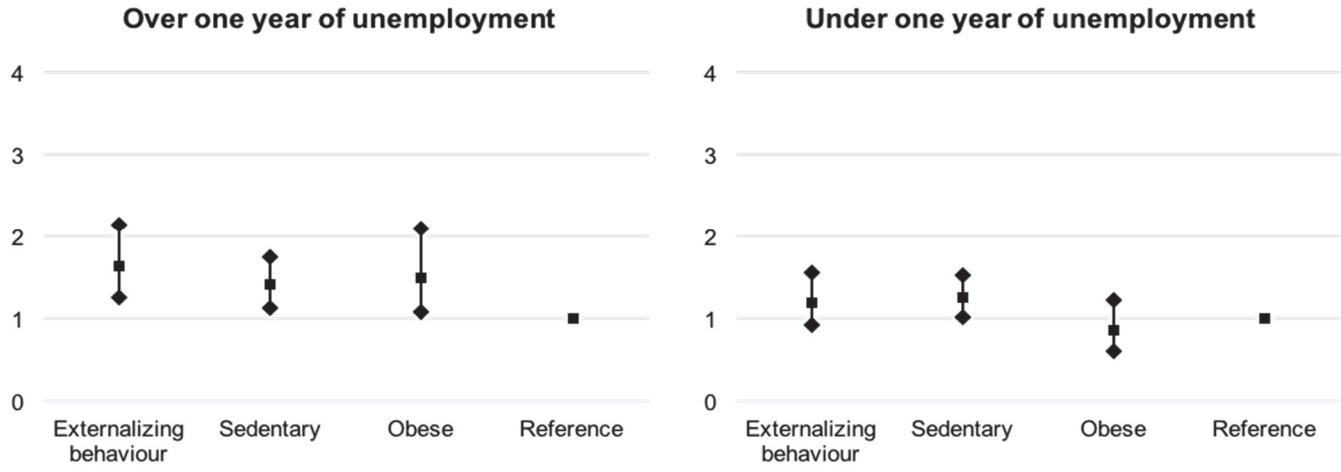

Fig. 14. Risk ratios and confidence intervals for associations between clusters at 16 years and unemployment at 25–29 years among men (n = 3225). 'No unemployment days' was used as reference. The analyses were adjusted for education, parental leave and family SES.

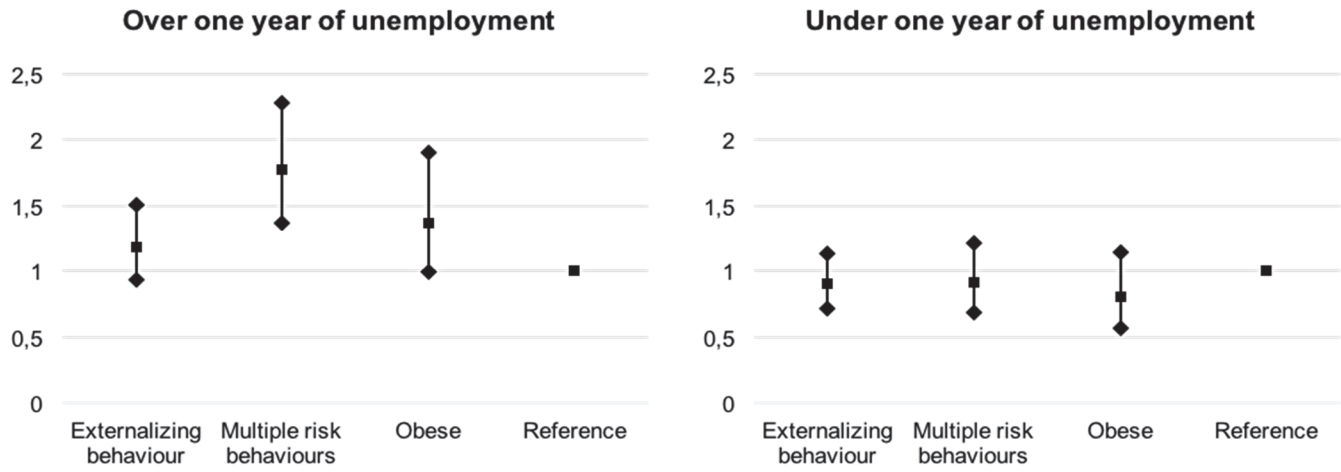

Fig. 15. Risk ratios and confidence intervals for associations between clusters at 16 years and unemployment at 25–29 years among women (n = 3544). 'No unemployment days' was used as reference. The analyses were adjusted for education, parental leave and family SES.

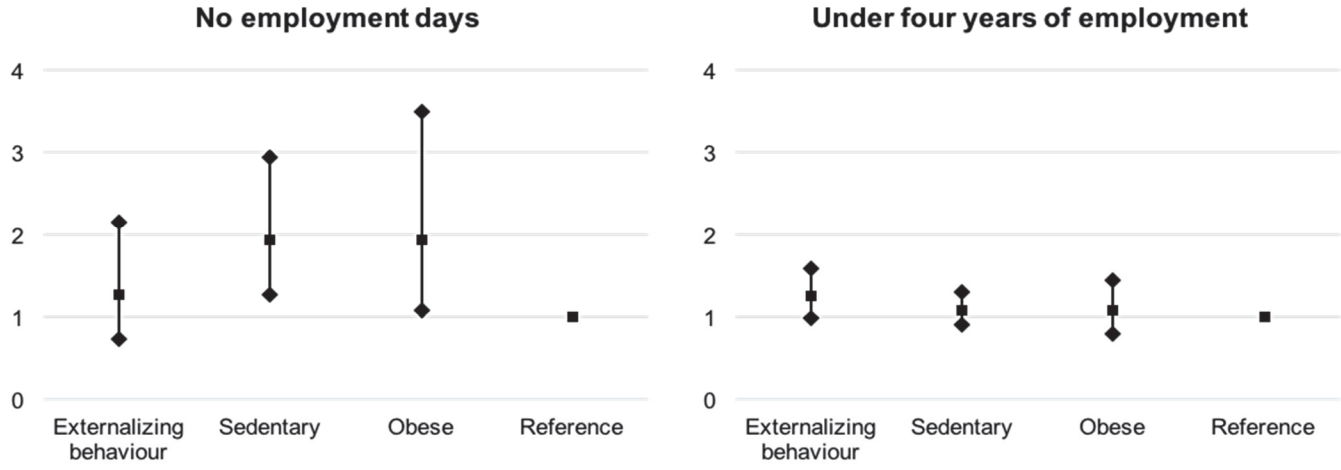

Fig. 16. Risk ratios and confidence intervals for associations between clusters at 16 years and employment at 25–29 years among men (n = 3225). 'Over four years of employment' was used as reference. The analyses were adjusted for education, parental leave and family SES.

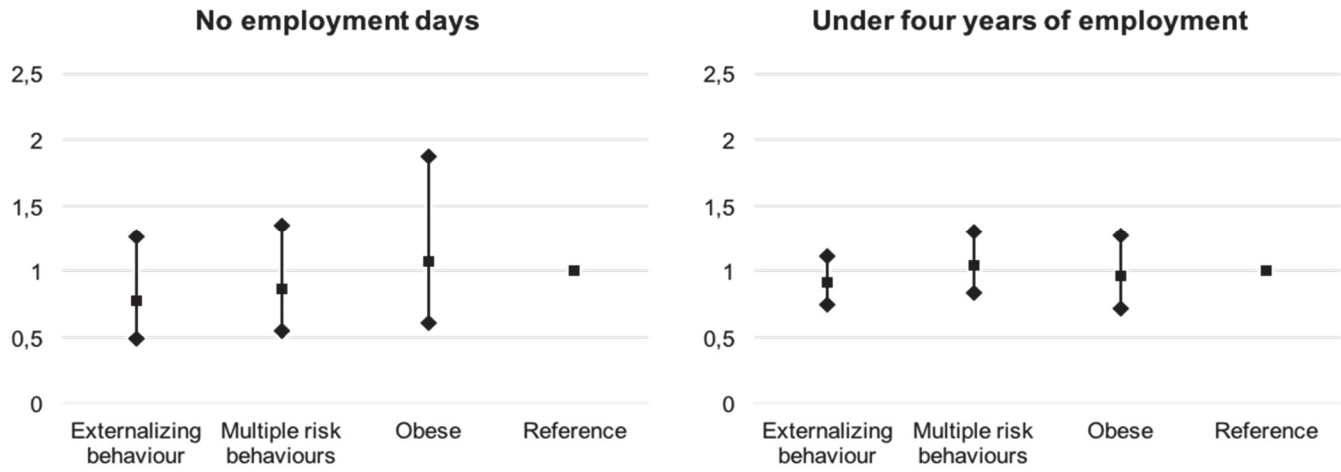

Fig. 17. Risk ratios and confidence intervals for the associations between clusters at 16 years and employment at 25–29 years among women (n = 3544). 'Over four years of employment' was used as reference. The analyses were adjusted for education, parental leave and family SES.

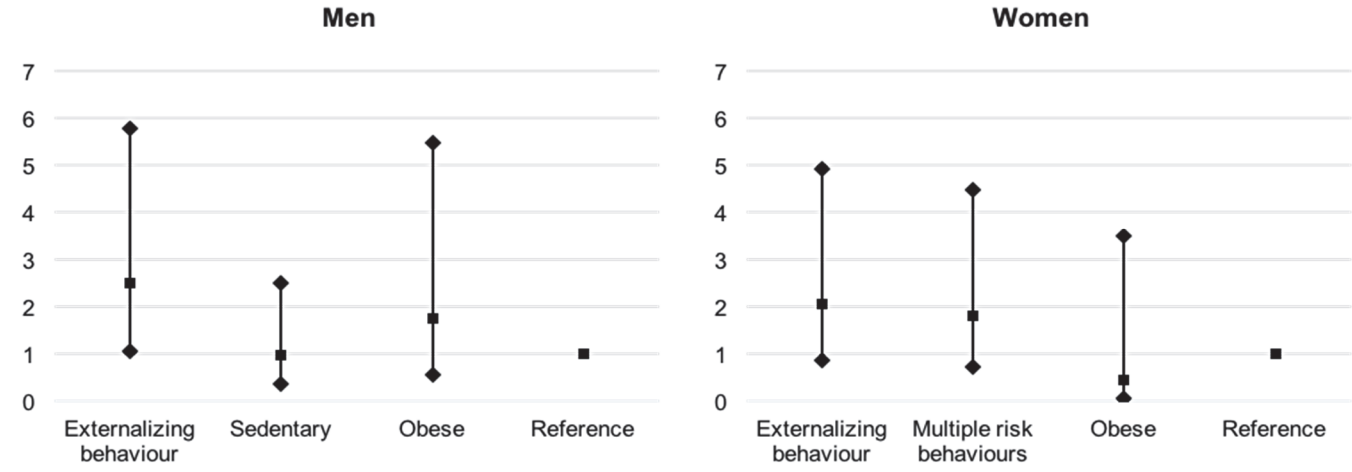

Fig. 18. Odds ratios and confidence intervals for associations between clusters at 16 years and permanent work disability at 25–29 years among men (n = 3259) and women (n = 3576). 'No permanent work disability' was used as reference. The analyses were adjusted for education, parental leave and family SES.

Table 21. Associations between multisite musculoskeletal pain at 16 years and cumulative unemployment, employment days, and permanent work disability between ages of 25 and 29 among cluster men and women.

Labour market outcome	Men		Women	
	Multisite musculoskeletal pain	No pain or one-site pain	Multisite musculoskeletal pain	No pain or one-site pain
Unemployment[a]	RR (95% CI)		RR (95% CI)	
Over one year	0.86 (0.71–1.03) (n = 260)	1.0	1.03 (0.86–1.23) (n = 488)	1.0
Under one year	0.96 (0.80–1.14) (n = 325)	1.0	0.94 (0.80–1.10) (n = 604)	1.0
No unemployment	1.0	1.0	1.0	1.0
Employment[a]	RR (95% CI)		RR (95% CI)	
No employment days	0.77 (0.52–1.12) (n = 49)	1.0	0.99 (0.71–1.38) (n = 115)	1.0
Under four years	1.03 (0.89–1.20) (n = 446)	1.0	1.04 (0.90–1.20) (n = 997)	1.0
Four years or over	1.0	1.0	1.0	1.0
Permanent work disability[b]	OR (95% CI)		OR (95% CI)	
Yes	1.40 (0.70–2.82) (n = 16)	1.0	1.47 (0.68–3.20) (n = 23)	1.0
No	1.0		1.0	

Adjusted for family SES, parental leaves and education. RR = risk ratio, OR = odds ratio, CI = confidence interval; [a] n = 3148 for men and n = 3480 for women, [b] n = 3180 for men and 3512 for women

6 Discussion

6.1 Main findings

> ***Research question 1***. *Do diverse, unhealthy behaviours and psychosocial problems co-occur and form distinct subgroups among 15–16-year-old adolescents? Does the prevalence of physical inactivity, overweight and smoking vary within these subgroups? Do these unhealthy behaviours persist in a two-year follow-up?*

Unhealthy behaviours and psychosocial problems co-occurred and formed four subgroups among both genders, labelled Externalizing behaviour, Sedentary, Obese, and Reference clusters among the men, and Externalizing behaviour, Multiple risk behaviours, Obese, and Reference clusters among the women. The prevalence of physical inactivity, overweight and smoking varied significantly within the subgroups and persisted in the follow-up.

> ***Research question 2***. *Are the accumulated unhealthy behaviours and psychosocial problems associated with LBP at 16 years or with new onset of LBP at 18 years after a two-year follow-up?*

Women with high levels of psychosocial problems who were also quite physically active and smoked at a moderate level (Externalizing behaviour cluster) were over three times more likely to consult a health care professional due to LBP at 18 years than the women in the Reference cluster. Having multiple adverse health-related behaviours (Multiple risk behaviours cluster) or being obese (Obese cluster) was related to reporting and/or consultation for LBP in the cross-sectional setting at 16 years among the women. Men belonging to the Externalizing behaviour cluster, in which psychosocial problems, smoking and a moderate/high level of PA accumulated, reported reporting LBP and consultation due to LBP more often than the Reference cluster at 16 years.

> ***Research question 3***. *Are the accumulated unhealthy behaviours and psychosocial problems associated with recurrent MMSP in a two-year follow-up?*

For both genders, belonging to clusters characterized by psychosocial problems, smoking and a moderate/high PA level; and for women, an accumulation of unhealthy behaviours were related to over a two-fold risk of recurrent MMSP in

the two-year follow-up. Inactive lifestyle and short sleeping hours (Sedentary cluster) were also related to recurrent MMSP among the men.

> ***Research question 4****. Are the accumulated unhealthy behaviours and psychosocial problems associated with register-based unemployment, employment, or permanent work disability during a five-year period at the ages of 25 and 29? Does MMSP influence the possible relations?*

All the men in the subgroups with adverse health-related behaviours and the women in the Multiple risk behaviours cluster were at a 1.5 to 3.0-fold risk of labour market inclusion problems. MMSP had no influence on the associations and did not associate with any labour market outcomes.

6.2 Comparison with previous studies

6.2.1 Comparison with other LCA studies of health-related behaviours among adolescents

LCA grouping, as other cluster analytic groupings, is heavily influenced by the selection and operationalization of the used variables (McAloney et al., 2013). The results may significantly vary depending on the variables included and their categorization. Therefore, a precise comparison between other studies and the current clusters is challenging. However, some similarities and differences can be observed.

In the present study, externalizing problems clustered with smoking and a subsequently high PA level among both genders. These adolescents were also highly likely to express internalizing problems. Along the same lines, Lawrence, Mollborn, and Hummer (2017) found that high PA and a moderate level of smoking co-occurred with having been in a fight during the last year among 15–17-year-old Americans. In a Mexican study of 11–16-year-olds, in turn, those who smoked had low rates of depression/suicide attempts (González-Fortega et al., 2017). However, in the most depressive cluster with definite suicide attempts, the prevalence of smoking was still the second highest of all the clusters (González-Fortega et al., 2017), indicating some similarities with the present results. However, these are not directly comparable with the current findings, as analyses of the formed LCA cluster characteristics have indicated that participants belonging to a cluster with a high level of smoking report more internalizing and externalizing problems than

others (Champion et al., 2018; Sutter et al., 2018). Adolescents with psychosocial problems may use cigarette products as self-medication for anxiety, which may partly explain the emergence of externalizing behaviour clusters. Participation in sports with aggressive characteristics has been related to increased cigarette use (Audrain-McGovern & Rodriguez, 2015), but these sport activities were not emphasized in the smoking clusters in the present study (data not shown).

The present study placed physical inactivity and sedentary behaviour with short sleeping time among the men and separated obese participants as their own subgroups in both genders. Inactive lifestyle was also relatively highly prevalent among the obese participants. A Canadian study of 13–18-year-olds exploring the patterns of screen time, PA, and sleeping time identified a physically inactive cluster with short sleeping times and a subsequently high amount of sedentary behaviour among both genders (Carson, Faulkner, Sabiston, Tremblay, & Leatherdale 2015). In studies by Kim, Barreira, and Kang (2016) and Kim, Umeda, Lochbaum, and Stegemeler (2016), conducted among 15–18-year-old Americans, clusters characterized by low PA level and a high amount of sedentary behaviour were found when both genders were considered simultaneously (Kim, Umeda, Lochbaum, & Stegemeler, 2016) and then separately (Kim, Barreira, & Kang, 2016). These clusters had the lowest ORs for getting sufficient hours of sleep (considered to be over 8 hours; Kim, Umeda, Lochbaum, & Stegemeler, 2016) and were at the highest risk of obesity (Kim, Barreira, & Kang, 2016). In line with the above observations, Parker, Salmon, Brown, Villanueva, and Timperio (2019) also found a subgroup of participants who were physically inactive and had a high level of sedentary behaviour, and observed that overweight/obesity was the most prevalent among these American adolescents. Champion et al. (2018), in turn, found a cluster in which the achievement of the recommended amounts of PA, sitting time and diet were poor.

However, more contradictory findings also exist. An *Inactive screenagers* cluster included the highest levels of physical inactivity and sedentary behaviour, but another two clusters of 15–18-year-old Canadians also had high likelihoods of sedentary behaviour (Laxer et al., 2017). Tabacchi et al. (2018) found only moderate levels of sedentary behaviour and low levels of overweight among physically inactive 16-year-old Italians, while in a US study by Burdette, Needham, Taylor, and Hill (2017), relatively low likelihoods of getting over 8 hours of sleep and exercising enough co-occurred with the highest probability of being the least sedentary. Among American adolescents aged between 15 and 17, physical

inactivity did not co-occur at all with sedentary behaviour and short sleeping time (Lawrence et al., 2017).

The presence of electronic devices in the bedroom might account for the accumulation of physical inactivity, short sleeping time and sedentary behaviour as they are likely to induce additional hours of sedentary activities (Christakis, Ebel, Rivara, & Zimmerman, 2004; Moreno et al., 2014) and lead to delayed bedtimes and frequent difficulties falling asleep (Bartel, Gradisar, & Williamson, 2015; Gamble et al., 2014), which in turn may result in reduced PA after school days due to tiredness. In contrast, PA tends to correlate with earlier bedtimes (Bartel et al., 2015) and provide good nocturnal sleep (Lang et al., 2016). Dietary habits not evaluated in the current study might be behind the separation of obese clusters as their own groups. Another LCA study of health behaviours in the NFBC1986 cohort (Jääskeläinen et al., 2014) grouped weight-control behaviours as separate clusters among both genders, and these clusters were at the highest risk of overweight and obesity.

Studies exploring multiple health-related behaviours have presented alternative results regarding the formation of an excessive multiple risk behaviours cluster. In a study by Burdette et al. (2017), a *High risk* group had the highest likelihood of all the studied adverse behaviours, except sedentary behaviour, whereas in a study by Laxer et al. (2017), PA, sedentary behaviour, unhealthy eating, and substance use (15 factors) were clustered into four subgroups, one of which showed the highest likelihoods of over half of the studied unhealthy behaviours. Among 10–17-year-old Chinese study participants, a distinctive 'high-risk' group with high probabilities of unhealthy behaviours and risk behaviours was found (Ji, Xu, Zhang, & Liu, 2018). Champion et al. (2018) observed several unhealthy behaviours emerging in two clusters of four, whereas studies by Jääskeläinen et al. (2014) and Lawrence et al. (2017) found no specific multiple risk cluster. Although none of the above studies evaluated psychosocial problems in the LCA model, psychological problems were more prevalent in the multiple risk clusters than in the other clusters (Champion et al., 2018). The results of the present study highlight the accumulation of both internalizing and externalizing problems and multiple unhealthy behaviours among female Finnish adolescents.

According to a recent review, 80% of cluster studies have discovered a Low risk/healthy lifestyle cluster in the general population (Noble, Paul, Turon, & Oldmeadow, 2015). Ten of 12 LCA studies of adolescents have found a healthy cluster, with a prevalence rate varying between 14% and 75%. Only a few studies have addressed activity patterns (Kim, Umeda, Lochbaum, & Stegemeler, 2016;

Parker et al., 2019), whereas most have included a range of health-related and risk-taking behaviour variables (Bianchi et al., 2017; Burdette et al., 2017; González-Fortega et al., 2017; Jääskeläinen et al., 2014; Lanza, Grella, & Chung, 2015; Lawrence et al., 2017; Laxer et al., 2017; Tabacchi et al., 2018). The two studies that did not yield a healthy/low risk cluster evaluated smoking, drinking, PA, sitting time, fruit and vegetable intake, and sleep duration among Australians (Champion et al., 2018); and diet, PA, internet use, smoking, binge drinking and other risk behaviours among Chinese living in a rural area (Ji et al., 2018). In line with the vast majority of LCA studies, the present study observed clusters with the lowest probabilities of the included unhealthy behaviours and psychosocial problems among both genders, and the prevalence of individuals in these clusters were also the highest of all the clusters.

6.2.2 Comparison with other MS pain studies

Psychosocial and psychological problems often co-occur with different MS pains already in adolescence (Mangerud, Bjerkeset, Lydersen, & Indredavik, 2013), and tend to influence the onset of MS pain (Huguet et al., 2016; Jones & Macfarlane, 2005), pain transformation from acute to chronic (Linton, 2000; Pincus, Burton, Vogel, & Field, 2002), and the persistence of MS pain (Huguet et al., 2016; Paananen, Taimela, et al., 2010). Mikkonen's thesis (2015) synthesized the current knowledge on the association between psychosocial problems and LBP in adolescence and found a positive relationship. Chronic WSP at the age of 45 was predicted by adolescent externalizing problems (at the age of 11–16) in a study conducted in Britain (Pang, Jones, Power, & Macfarlane, 2010). The most significant predictors of persistent MMSP were observed to be both internalizing and externalizing problems among the NFBC1986 adolescents (Paananen, Taimela, et al., 2010). In line with the previous literature, adolescents with accumulated internalizing and externalizing problems in the present study were at an increased risk of new onset of LBP and recurrent MMSP. It was also observed that the adolescents belonging to the externalizing behaviour cluster were physically active on average and that many of them smoked. In a study by McLaren et al. (2017), 14–16-year-old Australians suffering from problematic MS pain (most of which was multisite pain), more often smoked and had poorer mental health than those with no pain, lending support to our findings. Among adolescents and young adults participating in competitive sports with high levels of PA, depression (Belz et al., 2018) and stress (Heidari et al., 2019) have been associated with back pain, but

smoking and LBP have not been linked (Triki, Koubaa, Masmoudi, Fellmann, & Tabka 2015). An overview of systematic reviews (Kamper et al., 2016) summarized that smoking is related to the risk of LBP in adolescence and concluded that there might also be an association between high levels of PA and LBP. This was supported by a recent systematic review, in which 'participation in competitive sports' was observed to associate with a higher prevalence of LBP in most of the evaluated child and adolescent studies (Calvo-Muñoz, Kovacs, Roqué, Gago Fernández, & Seco Calvo 2018). In addition, high levels of PA (four or more hours per week) and smoking increased the risk of persistent MMSP in a two-year follow-up among the NFBC1986 adolescents (Paananen, Taimela, et al., 2010). It might be that these active adolescents are at a particular risk of injury-related pain, explaining the observed associations. Unfortunately, no data on pain aetiology was available to explore this more deeply.

In the present study, simultaneously having multiple unhealthy behaviours and psychosocial problems was associated with reporting LBP, consultation for LBP, and recurrent MMSP, which is in accordance with previous publications. A cross-sectional study of the NFBC1986 adolescents (Paananen, Auvinen, et al., 2010) observed that an increasing number of unhealthy behaviours and psychosocial problems multiplied the risk of MMSP. Hoftun et al., (2012) evaluated several health-related behaviours, including sedentary behaviour, PA, overweight/obesity, smoking, and alcohol intoxication among Norwegian adolescents, and also noticed a cross-sectional dose-response relationship between the number of unhealthy behaviours and chronic multisite pain (including pains other than MS). In another Norwegian cross-sectional study, adolescents aged 13–19 with a high score in psychiatric symptoms had a high prevalence of chronic multisite pain comprised of head and abdominal pain, and different MS pain sites (Skrove, Romundstad, & Indredavik, 2015). Consistent with these findings, persistent chronic widespread pain was also more prevalent after one-year follow-up among adults with a higher number of baseline psychological problems (McBeth, MacFarlane, Hunt, & Silman, 2001). The present study's finding that the Multiple risk behaviours cluster women were likely to consult a health care professional for LBP may be related to the psychosocial problem burden seen among these women in general (Kekkonen et al., 2015; Vingilis, Wade, & Seeley, 2007).

The co-occurrence of inactive lifestyle and short sleeping time was related to recurrent MMSP among men in the current study. However, these men were not at an increased risk of LBP. Along the same lines, Paananen, Taimela, et al., (2010) reported a relationship between a high level of sedentary behaviour and persistence

of MMSP among NFBC1986 members, and Hoftun et al., (2012) found an association between chronic multisite pain and sedentary behaviour. However, in these studies, physical inactivity (Hoftun et al., 2012; Paananen, Taimela, et al., 2010) and short sleeping time (Paananen, Taimela, et al., 2010) did not associate with persistent MMSP or chronic multisite pain. Among 17-year-olds in Britain, in turn, the presence of chronic fatigue syndrome, characterized by problematic tiredness, which may at least partly be caused by too short sleeping times, was found to be related to chronic WSP (Norris, Deere, Tobias, & Crawley, 2017). The disparities in the findings may be due to the different methodologies and variable classification used, but on the other hand, engaging in all three unhealthy behaviours simultaneously seems to matter. With respect to LBP, previous reviews have found mixed results in relation to the influence of adolescent sedentary behaviour and physical inactivity on the risk of LBP (Balagué, Troussier, & Salminen, 1999; Cardon & Balagué, 2004; Jones & Macfarlane, 2005; Kamper et al., 2016). A meta-analysis has suggested that regular exercise in adolescence might reduce the likelihood of the onset of LBP in adulthood (Huguet et al., 2016). A systematic review found that sleep quantity or quality, or daytime tiredness were not risk factors of LBP onset in childhood or adolescence (Andreucci, Campbell, & Dunn, 2017).

In the present study, obesity was only related to seeking treatment for LBP among women, cross-sectionally; not to reporting LBP, new onset of LBP or recurrent MMSP. This is in fair agreement with prior research. A summary of systematic reviews showed varying findings regarding the association between BMI and back pain, with one review reporting a relationship, two reporting no clear relationship, and two reporting no association (Kamper et al., 2016). For example, a large cross-sectional Israeli study of over 800 000 adolescents aged 17 found an association between LBP and overweight/obesity (Hershkovich et al., 2013), whereas a systematic review of a large number of studies (mainly cross-sectional) synthesized that most of the studies found no relationship between BMI and the prevalence of LBP (Calvo-Muñoz et al., 2018). A previous review (Jones & MacFarlane, 2005) or meta-analysis (Huguet et al., 2016) found no relationships between adolescent BMI and subsequent LBP in longitudinal settings. A meta-analysis by Shiri, Karppinen, Leino-Arjas, Solovieva, and Viikari-Juntura (2010), however, observed that obesity related significantly to seeking care for LBP among adults. As regards recurrent multisite pain, overweight and obesity were not related to persistent MMSP in a study by Paananen, Taimela, et al. (2010). Along the same

lines, Deere et al. (2012) observed no significant cross-sectional associations between obesity and CWP among 17-year-olds in the UK.

Possible mechanisms for some of the associations between health-related behaviours and MS pain

Central nervous system sensitization and psychological mechanisms are likely to play a role in the experience of MS pain (Hartvigsen, Natvig, & Ferreira, 2013). Prolonged psychological stress may predispose an individual to pain and its spreading to multiple sites by affecting sensory processing (Clauw & Williams, 2002). Internalizing problems may also impede pain coping strategies by enhancing, for example, fear avoidance behaviours (Jastrowski Mano, O'Bryan, Gibler, Beckmann, 2019) and pain catastrophizing (Vervoort, Eccleston, Goubert, Buyess, & Crombez, 2010), which are significantly related to pain (Jastrowski et al., 2019; Vervoort et al., 2010). High sport levels, in turn, may endanger adolescent MS health through trauma or cumulative microtrauma caused by overuse of the MS system (d'Hemecourt, Gerbino, & Micheli, 2000). Of the proposed mechanisms of the effect of tobacco use on MS pain, the most commonly suggested is the structural damage to the body caused by nicotine exposure (Shi, Weingarten, Mantilla, Hooten, & Warner 2010). It has also been proposed that hormonal differences may account for gender differences in pain perceptions (Fillingim, King, Ribeiro-Dasilva, Rahim-Williams, & Riley 2009). The discrepancies between pain reporting among adolescent men and women might also be explained by differences in exposure to unhealthy behaviours and psychosocial problems.

6.2.3 Unemployment among young adults

In the current study population, nearly half of the young adults had received unemployment benefits between the age of 25 and 29. A study of the cohort of all Finnish young adults born in 1986 reported that almost 60% had registered unemployment days by the age of 25 (Sutela et al., 2016), which along with our findings, indicates a high prevalence of unemployment between adolescence and early adulthood in Finland. Prior studies conducted during the time span from the 1980s to the early 2000s have found the prevalence of experiencing at least one day of unemployment to be 61% between the ages of 18 and 32 in New-Zealand (Landhuis et al., 2012) and 41% between the age of 16 and 33 in Britain (Montgomery, Cook, Bartley, & Wadsworth, 1998). A more recent Swedish study

from 2005–2011 showed that approximately 25% of 20- to 35-year-olds had had register-based unemployment days during the years studied (Helgesson et al., 2017). At least part of the high prevalence of unemployment is related to short-term employment (Quintini et al., 2007), difficulties finding a permanent job after graduation (Quintini et al., 2007), and the gap year phenomenon. Some young Finns may also have been employed in seasonal jobs only, receiving unemployment benefits in the meantime. Polarization of employment and unemployment among young people has been noted in some OECD countries (Quintini et al., 2007), and some aspects of this phenomenon were also observed among the young adults of the present study population, as nearly half of the participants who had received unemployment benefits during the follow-up had been unemployed for over a year.

6.2.4 Relations to other studies of health-related behaviours and labour market outcomes

In the current study, accumulated unhealthy behaviours and psychosocial problems had an impact on difficulties in labour market inclusion. Only a few prior publications have recognized the joint association of unhealthy behaviours and psychological problems with different labour market outcomes. Rodwell et al. (2018) observed that Australian adolescents aged 14–15 with both mental or externalizing disorders and cannabis use had a probability of 20% of not being in education or employment in early adulthood compared to a probability of 5% among people with no risk factors. In a Norwegian study by de Ridder et al. (2015), the risk of having received long-term sickness and/or disability benefits at the age of 20–29 increased with the adolescent/young adult-accumulated health risk burden, including smoking, overweight/obesity, sleep disturbances, poor concentration, and symptoms of anxiety and depression. In their study of British children and adolescents, Goldman-Mellor et al. (2016) suggested that the prevalence of NEET status at 18 years increases with an increasing number of mental health problems, substance use or suicidal behaviour suffered earlier during childhood and adolescence. Concurrently, women with multiple adverse health-related behaviours and smoking men with externalizing problems were at an increased risk of later labour market exclusion in the present study.

Only a few adolescent studies have previously provided information on the influence of specific health-related behaviour combinations on the risk of labour market exclusion. In a study with over a million participants (Henriksson et al., 2019), Swedes aged 16 to 19 who were unfit and obese were at the highest risk of

later receiving disability pension in comparison to those with other combinations of fitness and weight categories. Another Swedish publication conducted among military men studied the possible combined effect of smoking and obesity on disability pension but observed no synergistic role of these behaviours in predicting disability pension (Neovius, Neovius, & Rasmussen, 2010). In the current study, the Obese cluster, in which a high BMI and relatively low levels of PA and smoking were present, did not relate to permanent work disability, but to over one year of unemployment and to 'no employment days' among the men. It seems that obese participants with a low rate of smoking are not likely to be at risk of subsequent disability pension either. In the first Swedish publication, the follow-up period of having received disability pension was 40 years. Perhaps different disorders and diseases accompanied by overweight/obesity and poor fitness/physical inactivity lead to work disability in the long run but are not yet relevant among young adults. However, in the present study adolescent high BMI with a subsequent low physical activity level was found to be relevant with respect to unemployment and employment in early adulthood. Overweight/obese individuals are likely to be predisposed by reduced productivity (Sanchez Bustillos, Vargas, & Gomero-Cuadra, 2015) and to be more socially isolated in comparison to their normal-weight counterparts (Strauss & Pollack, 2003), which may partly explain these results. Furthermore, intuitively, employers may favour young people who appear fit in their selection procedure, which might influence obese individuals' employment opportunities during early adulthood.

Interestingly, the Externalizing behaviour cluster women did not relate to any labour market outcome in the present study. In a Finnish follow-up study of adults, never-smokers, ex-smokers and moderate smokers were at a risk of disability retirement when their PA level was low or moderate, but not when it was high (Lallukka, Rahkonen, Lahelma, & Lahti, 2015), lending some support to this result. Unfortunately, the analyses of the study were not stratified by gender. The observed gender differences may be related to the fact that the women in the other clusters were more physically inactive than those in the Externalizing behaviour cluster, as a high PA level has been observed to reduce job strain (Yang et al., 2010), for example, and have positive impacts on work ability (van den Berg, Elders, de Zwart, & Burdorf, 2009). However, it might also be that the influence of psychosocial problems on labour market inclusion depends on concurrent health behaviours, as an association between the Multiple risk behaviours cluster and poor labour market outcomes was acknowledged.

In the current study, belonging to clusters of unhealthy behaviours and psychosocial problems, especially among the men, exposed adolescents to later labour market exclusion, even after adjusting for education, parental leaves, and family SES. These results are supported by previous observations showing the relationships between PA (Kari et al., 2016), sedentary behaviour (Landhuis et al., 2012), smoking (Brook et al., 2014), sleep disturbance (de Ridder et al., 2015), and psychosocial problems (e.g. Narusyte et al., 2017, Pape et al., 2012) and various labour market outcomes. Adolescents with psychosocial difficulties might be more vulnerable to stress than others, which may hamper their survival in the labour market. On the other hand, psychosocial problems and smoking may persist into early adulthood and also increase the risk of mental health problems among adults (Gore et al., 2011; Hofstra, Van Der Ende, & Verhulst, 2001; U.S. Department of Health and Human Services, 2012), which, in turn, may result in work impairments. However, it has also been suggested that child/adolescent psychiatric/psychological problems might play an independent role in later working life survival, regardless of young adult or adult psychiatric/psychological problems (Clark et al., 2017; Copeland, Wolke, Shanahan, & Costello, 2015). The short sleeping times and inactive lifestyle seen in the Sedentary cluster, on the other hand, may have an impact on general productivity which, together with lower school performance (Millman, 2005), may reflect poor labour market inclusion.

No signs were observed that MMSP plays an independent role in labour market exclusion, regardless of the associations of the clusters with the labour market outcomes. This finding contradicts our hypothesis based on previous adult studies (Haukka et al., 2015; Miranda et al., 2010). The different MMSP measures might explain the differences in the results, as the other studies inquired about pain during the previous month. Perhaps taking pain intensity or frequency into account would have changed the current results, but on the other hand, these aspects of pain were not elicited in the studies of Haukka et al. (2015) and Miranda et al. (2010) either. It may be that the pain experienced in adolescence is not clinically as relevant as MMSP reported in adulthood.

6.3 Methodological considerations

6.3.1 Limitations

The present study used self-reported values of health-related behaviours (except BMI), LBP and MMSP, which is a limitation, as self-reporting may involve recall bias and may be affected by different internal and external conditions (Williamson, 2007). However, self-reported estimates are likely to be superior to estimates gathered from parents or teachers (Achenbach, McConaughy, & Howell, 1987; Hurtig, Taanila, Ebeling, Miettunen, & Moilanen 2005; Sourander, Helstelä, & Helenius, 1999; van Roy, Groholt, Heyerdahl, & Clench-Aas, 2010) and provide advantages when gathering information from a large number of respondents, as was the case in the current study population, in comparison to objective tools, such as accelerometers. Self-reported values are widely used in the research field of health behaviours and MS pain problems, and earlier studies have suggested self-reporting to be a reliable method for collecting information on adolescents' health-related behaviours at the population level (Achenbach & Rescorla, 2001; Post et al., 2005; Tammelin et al., 2007). Furthermore, objective measurements do not exist, especially in pain research, and it should be kept in mind that some psychosocial symptoms cannot be objectively measured.

More men than women (32% vs 21%) did not answer the YSR questionnaire properly or even at all. A higher proportion of adolescents who did not complete the YSR questionnaire had externalizing problems in another NFBC1986 study in comparison to those who had provided data on psychosocial problems (Hurtig et al., 2005). Thus, men may have more psychosocial problems, especially externalizing problems than the present study estimates. As regards internalizing and externalizing problem scales, one must keep in mind that problem and normal ranges are not clinical estimations.

The total activity/inactivity patterns of the adolescents were not available for evaluation since PA and sedentary activity levels at school were not elicited in the questionnaire at 16 years. However, PA classes are held at school and are obligatory for each adolescent. Along the same lines, each adolescent spent roughly the same number of hours sitting in the classroom during school days. Therefore, PA and sedentary activity levels at school tend to be similar among adolescents, and activity patterns outside school hours are likely to provide more information on the kind of PA that depends on the adolescents themselves.

One major limitation of the present study is that no data on MS pain frequency, intensity, or pain-related activity limitations were available, and pain was only assessed on two occasions in the two-year follow-up. For instance, a participant may have had temporal MMSP twice during the follow-up period, or the whole six-month time period preceding the follow-up check point. Some may also have suffered pain at only these ages but not in between. Consequently, the clinical relevance of the studied MS pains may be questioned, and this needs to be considered when interpreting the results of this study. Reported MS pain without knowledge of other characteristics (intensity, etc.), however, has been related to health-related quality of life (Paananen et al., 2011) and functioning (Bruusgaard, Tschudi-Madsen, Ihlebæk, Kamaleri, & Natvig 2012), for example, especially among MMSP sufferers.

Furthermore, the study did not evaluate whether the participants had MS pains in the same or different locations in the two-year follow-up, as the interest was only in the recurrence of multisite MS pain in general and not in the locations affected. The questionnaires did not separate pelvic, febrile- or pregnancy-related pain, which may have overestimated the prevalence of pain in the MS system, particularly among the women. Reporting and consultation for LBP were employed as separate LPB categories, but as the small sample size limited the separation of reporting and consultation for MMSP in the MMSP study, they were combined.

Due to the structure of the registered data, the present study was unable to separate paid days from sickness absence or maternity leave days, as a person can simultaneously receive benefits for both, depending on work contracts. Thus, employment days are likely to be slightly overestimated. Furthermore, this study was unable to explore whether paid employment days resulted from working only a few hours or a whole day. However, having received payment for work is likely to indicate the existence of a true connection to the labour market. With respect to unemployment days, some of them may have comprised temporary lay-offs or unemployment allowance received during school holidays, which may slightly overestimate their total number. A low number of young adults had permanent work disability, diminishing the power of these analyses. No data were yet available on young adults' health-related behaviours in the NFBC1986 cohort, which is another limitation. Part of the analyses was cross-sectional in nature and thus no inferences of the cause-and-effect relationships can be made from the cross-sectional results.

6.3.2 Strengths

The main strengths of the current study were its population, follow-up design, good response rate, and registered data on multiple aspects of labour market inclusion. The study sample was composed of a large birth cohort of adolescents, 80% of whom participated in the 16-year sample collection. Representativeness analyses of the OBS subcohort and non-OBS participants among the cluster participants belonging to the NFBC1986 showed only slight differences, and therefore OBS study populations may be regarded as representative of the baseline population. The register-based data provided objective, reliable information with no recall bias on unemployment, employment, permanent work disability, education, and parental leave, being available for all the cluster participants. Most of the analyses used a prospective setting. However, reverse causality cannot be totally excluded in MS pain studies and some unobserved characteristics might have correlated with both baseline and follow-up variables, which would explain the findings. This should be kept in mind while interpreting the current results. Most importantly, this is the first study to explore the associations between accumulated unhealthy behaviours, psychosocial problems and LBP and recurrent MMSP during adolescence and labour market inclusion a decade later during a critical period of working life among a large set of Finnish participants.

6.4 Implications of study and suggestions for future studies

The results of the current study show that a significant proportion of adolescents have MS pain problems, and that many young adults struggle with labour market inclusion problems. Adolescents often adopt several unhealthy behaviours, such as physical inactivity, short sleeping times, sedentary behaviour, overweight/obesity, and smoking, which tend to appear concurrently with psychosocial problems. The accumulation of these unhealthy behaviours and psychosocial problems is related to low back and multisite pains in adolescence, and unemployment, employment and permanent work disability in early adulthood. Fortunately, most of the young seem to adhere to healthy behaviours with low risks of future pain and labour market problems. Interestingly, two or more pain sites in adolescence does not seem to predict difficulties in labour market inclusion during early adulthood.

According to the present results, the occurrence of internalizing and externalizing problems, smoking and a subsequently high PA level or accumulation of a range of unhealthy behaviours are particularly harmful to adolescents with

respect to the risk of LBP and recurrent MMSP. Significant gender differences exist, especially in LBP risk, with more associations among women than among men. The current findings provide new perspectives for understanding the nature of MS pains and for the evaluation of MS pain determinants. They also emphasize that screening for both unhealthy behaviours and psychosocial problems is essential among LBP and MMSP sufferers.

Sustained labour market inclusion in the early years of working life is relevant due to increasing pressure from national economic forces to extend working lives on the one hand and the fact that participation in working life and earning an income plays a significant role in establishing a position in society on the other. The present study lends valuable support to the previous literature, indicating that preventive work aimed at reducing the risk of labour market exclusion should be started already during adolescence when individuals are at a critical stage of life in relation to engaging in unhealthy behaviours. Special attention and support at school and in the social environment should be especially targeted towards men with unhealthy behaviours and psychosocial problems and women with a burden of these behaviours, to prevent their exclusion from the labour market. Prompted by the current observations, it may well be that the polarization in health-related behaviours among adolescents predicts later polarization in labour market survival.

In the current study, a number of adolescents engaged in more than one unhealthy behaviour at a time, and a significant proportion of them simultaneously had psychosocial problems, especially the women. On the other hand, over half of the participants had a healthy pattern of health-related behaviours, indicating that those who succeeded did so in a broad sense. The present results stress the significance of simultaneous and gender-stratified evaluation of psychosocial problems and unhealthy behaviours among adolescents. Although lifestyle change is known to be difficult in general, adolescence may, however, be a unique time period with respect to altering the adverse directions of health-related behaviours, as adolescents are likely to be vulnerable to not only detrimental but also advantageous stimulus (see ‘Adolescence’ chapter). Multiple behaviour interventions have been increasingly studied and the efficacy of their methods should be explored in the subgroups formed.

Additional studies are needed to verify the present findings. Generally, the results need to be confirmed in other cohorts and cultures in a longitudinal setting, as the current study sample was drawn from Northern Finland adolescents. Moreover, although significant relationships between health-related clusters and reported LBP and MMSP were detected, further research is needed to verify the

existence of these associations when a variable constructed from consequential pain is used as a pain outcome. Furthermore, it is important to study the sustainability of the labour market results while taking young adults' health-related factor trajectories into account, as obtaining and maintaining a healthy lifestyle seems to be related to maintaining work ability among adults (Nevanperä et al., 2016). In addition, the early predictors of cluster memberships and the characteristics of the subgroups formed by more objectively measured factors will be relevant research questions in the future. The forthcoming follow-up of the cohort data will provide an opportunity to ascertain the role of adolescent health-related behaviours in labour market outcomes after the young adults' health behaviours have been followed up.

7 Conclusions

Psychosocial problems and unhealthy behaviours clustered into four distinct subgroups among Finnish adolescents. Psychosocial problems and an accumulation of smoking or a number of unhealthy behaviours were highlighted in the subgroups, explaining both MS pains and delays in labour market inclusion. Adolescent MMSP played no role in later labour market outcomes.

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ACTA UNIVERSITATIS OULUENSIS

ISBN 978-952-62-2575-3 (Paperback)
ISBN 978-952-62-2576-0 (PDF)
ISSN 0355-3221 (Print)
ISSN 1796-2234 (Online)