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Long-lasting obesity predicts poor work ability at midlife: A 15-year follow-up of the Northern Finland 1966 Birth Cohort Study

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Corresponding Author:	Nina Nevanperä Finnish Institute of Occupational Healt Oulu, FINLAND
Corresponding Author Secondary Information:	
Corresponding Author's Institution:	Finnish Institute of Occupational Healt
Corresponding Author's Secondary Institution:	
First Author:	Nina Nevanperä
First Author Secondary Information:	
Order of Authors:	Nina Nevanperä
	Leena Ala-Mursula, MD PhD
	Jorma Seitsamo, PhD
	Jouko Remes, MSc
	Juha Auvinen, MD, PhD
	Leila Hopsu, MSc
	Päivi Husman, MSc
	Jaro Karppinen, MD, PhD
	Marjo-Riitta Järvelin, MD, PhD
	Jaana Laitinen, PhD
Order of Authors Secondary Information:	
Manuscript Region of Origin:	FINLAND
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Editor-in-Chief Paul W. Brandt-Rauf

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Dear Editor-in-Chief Paul W. Brandt-Rauf,

Please find attached our manuscript “Long-lasting obesity predicts poor work ability at midlife: A 15-year follow-up of the Northern Finland 1966 Birth Cohort Study”. We offer it for publication in the Journal of Occupational and Environmental Medicine.

Sincerely yours,

Nina Nevanperä

Finnish Institute of Occupational Health

nina.nevanpera@ttl.fi

Long-lasting obesity predicts poor work ability at midlife: A 15-year follow-up of the Northern Finland 1966 Birth Cohort Study

Nevanperä Nina[1], MSc; Ala-Mursula Leena[2], MD, Seitsamo Jorma[1], PhD; Remes Jouko[1], MSc; Auvinen Juha[2], MD, PhD; Hopsu Leila[1], MSc; Husman Päivi[1], MSc; Karppinen Jaro[1,2], MD, PhD; Järvelin Marjo-Riitta[2,3,4,5,6], MD, PhD; Laitinen Jaana[1*], PhD

[1] Finnish Institute of Occupational Health, Helsinki, Finland

[2] Faculty of Medicine, Center for Life Course Epidemiology and Systems Medicine, University of Oulu, Oulu, Finland

[3]Medical Research Center Oulu, University of Oulu and Oulu University Hospital, Oulu. Finland

[4]Department of Epidemiology and Biostatistics, MRC Health Protection Agency (HPE) Centre for Environment and Health, School of Public Health, Imperial College London, UK

[5] Biocenter Oulu, University of Oulu

[6] Unit of Primary Care, Oulu University Hospital, Oulu, Finland

***Corresponding author:**

Nina Nevanperä

Finnish Institute of Occupational Health, Aapistie 1, 90220 Oulu, Finland

Tel: +358 30 474 6006, fax: +358 03 474 6121, e-mail: nina.nevanpera@ttl.fi

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Conflicts of Interest and Source of Funding

All authors declare that they have no conflict of interest.

Running title: Obesity and work ability

Long-lasting obesity predicts poor work ability at midlife: A 15-year follow-up of the Northern Finland 1966 Birth Cohort Study

Abstract

Objective: To investigate the effect of adulthood obesity on work ability in early midlife during a 15-year follow-up.

Methods: The study population included men and women (n=5470), born in northern Finland in 1966. Participants evaluated their current perceived work ability compared to their lifetime best at the age of 46. Participants' weight and height were measured at 31 years and self-reported at 46 years, and BMIs were calculated.

Results: Obesity at both ages, and developing obesity between the ages of 31 and 46 increased the relative risk of poor work ability at 46 years among both genders, and among those in both low and high physically strenuous work.

Conclusions: Long-term obesity and developing obesity in mid-adulthood increase the risk of poor work ability. Thus, the promotion of healthy behaviours by policies, health care services and at workplaces is important.

Introduction

Good work ability is associated with perceptions of enjoyment, high quality and high productivity at work, as well as a good level of functioning at retirement [1]. Poor work ability in turn associates with increased sickness absences and preterm retirement [2-4].

One third of the world's population (i.e. 2.1 billion people) is overweight or obese today [5]. Obesity increases the risks of several diseases and is associated with a higher prevalence of sick leaves and disability pensions, especially due to musculoskeletal diseases, cardiovascular diseases and mental disorders [6-12]. Furthermore, a recent study observed that weight gain among women with normal weight was also associated with sickness absence and thus temporal work disability [13].

Obesity and a high body mass index associate with an increased risk of poor work ability measured by the Work Ability Index or its sub-items in cross-sectional studies [1, 14-19]. However, as far as we know, only two longitudinal studies have studied the effect of obesity on work ability [14, 20]. The first found that obesity since adolescence associated with poor work ability among 31-year-old women, but not among men [20]. The second study included only female home care workers of different ages and observed that those with obesity at baseline were at a higher risk of poor work ability five years later [14]. Neither of these focused on work ability in early midlife, although work ability in midlife is an important determinant of the length of one's working career, since work ability diminishes with age [23, 24, 25].

Associations between obesity and work ability may be complex, and influenced by work-related factors. High physical workload increases the risk of poor work ability [22, 23] especially among those with cardiovascular diseases or diabetes [23,24] or with osteoarthritis [26]. Thus, it is important to find factors that affect work ability in physically strenuous work in order to develop effective strategies and practices. Obesity may be one risk factor, but little is known about the joint effects of obesity and physically strenuous work on work ability.

Socioeconomic factors may have an effect on the association between obesity and work ability. People with a low level of education and/or occupational class are also at an increased risk of obesity [28-31]. People with a lower socioeconomic position may work more often in physically demanding positions, and physical strain may to some extent explain the socioeconomic inequalities in work ability [27]. Physical working conditions have partially explained the occupational class differences in physical health functioning and self-perceived health [32, 33] which all are associated with lowered work ability [23].

Social support at work and health behaviours may contribute to the associations between obesity and work ability. Social support may be noteworthy for work ability, and lack of social support at work has associated with an increased risk of obesity [34, 35]. The association between obesity and lack of social support may be mediated through unhealthy coping styles such as stress-related eating and drinking, since health behaviours associate with work ability [18-20, 36, 37].

Therefore, the objectives of this 15-year follow-up study were to investigate the effects of weight classes (normal weight, overweight and obese) and developing obesity (BMI ≥ 30.0) on work ability in early midlife. Specifically, we investigated the joint effects of obesity and physically strenuous work on work ability by stratifying the analyses by the physical strenuousness of work.

Material and Methods

Study population and data collection

The study population was the Northern Finland 1966 Birth Cohort (NFBC 1966), which consists of mothers and their children who were due to be born in the provinces of Oulu and Lapland in 1966 (Figure 1)[38, 39]. Altogether, the final cohort data comprised 96.3 per cent of all births during 1966 in that area. The study population was followed-up the participants were 46 years old, and data were collected via questionnaires and/or clinical examinations at birth and at the ages of 1, 14, 31 and 46 years.

At the age of 14 in 1980, a postal questionnaire was sent to the children, and if they did not respond, to their parents, and further to the regional school offices and school health nurses. Altogether, data were received from 11 010 people (93.6%) [40]. At the age of 31 in 1997, the postal questionnaires were sent to participants who were alive and traced (97.2%). Those living in northern Finland or the metropolitan area during the survey were invited to clinical examinations during which they filled in a supplementary questionnaire concerning working life (n=5713). Women who were pregnant (n=154) at the time of the 31-year survey were excluded from these analyses. At the age of 46 in 2012, 10 300 of the participants were alive and traced (85.4%). All participants were given the opportunity to respond to two web-based questionnaires (1) Background, life style and health questionnaire; 2) Finances, work life and resource questionnaire) on the internet. If the participants did not have a computer, postal inquiries were sent to them. We included in the analyses all participants for whom data on current perceived work ability at 46 years, and weight and height at 31 and 46 years were available (Figure 1).

The study was approved by the Ethics Committee of the Finnish Institute of Occupational Health and by the Ethics Committee of the Northern Ostrobothnia Hospital District. At all stages of the study, the participants gave written informed consent according to the Declaration of Helsinki.

Outcome and explanatory measures

Current perceived work ability compared to lifetime best was used as an outcome measure and was evaluated on a scale of 0 to 10 at the age of 46. This is the first item of the Work Ability Index, and is proven to be a valid item for work ability assessment [41-44]. Participants were dichotomized into either good (8– 10) or poor (0– 7) work ability.

Explanatory factors were weight status at the age of 31 and change in weight status between the ages of 31 and 46. Although obesity (BMI$\geq$30.0 kg/m^2) increases the risk of diseases with ageing, it can be also used as an early sign of the development of diseases leading to work disability. At the age of 31, we used measured weights and heights and replaced missing

values with self-reported values. At the age of 46, the values were self-reported. BMIs (kg/m^2) were calculated and divided into classes: normal weight (BMI <25.0), overweight (25.0– 29.9) and obese (≥30.0). Longitudinal weight classes from 31 to 46 years were defined as follows: 1) normal weight (BMI <25.0) 2) overweight (BMI 25.0-29.9), 3) always obese (BMI always ≥30.0), and 4) became obese: BMI increased from 18.5-29.9 to ≥30.0.

We used physically strenuous work at the age of 46 when stratifying the analyses. This was evaluated using the question "To what extent are the following tasks and postures part of your job?"[46]. The participants had to evaluate certain tasks (e.g. "heavy physical work in which the body has to struggle", "lifting loads over 15kg") and postures (e.g. "standing", "bending") in their work, through nine questions. The responses were recoded as follows: 0=not at all or very rarely and seldom and 1=moderately, often and very often, and then summed (range 0-9). The median was used as a cut-off point value for defining physically strenuous work (no/yes). Physically strenuous work at the age of 31 was elicited and used as a covariate in multivariate analyses.

Covariates

Analyses were controlled for basic education (matriculation examination yes/no), social support at 31 years, health behaviours at 31 years and work history.

Social support at work was evaluated using four questions at the age of 31 years. "If you had stressful problems with interpersonal relations, mental health or work,, how much emotional support would you receive in the form of listening and advice from 1) your colleagues and 2) your boss?" and "If you were in a difficult situation that you could not cope with on your own (e.g. arranging child care, lack of money, insurmountable problem with work), how much practical help would you receive from 3) your colleagues and 4) your boss?". The response alternatives were not at all / I do not want any support (1), a little, some, quite a lot, and a lot (5). Sum scores of these questions and answer alternatives were calculated (scores 4 to 20) and divided into three groups on the basis of tertile cut-off values (not at all/slightly, some, quite a lot /a great deal).

Health behaviours included physical activity, smoking, alcohol consumption and stress-related eating and drinking at the age of 31 [37, 46]. Physical activity was evaluated by eliciting the frequency of light and brisk leisure time physical activity and was scored into three groups: active/very active (0), moderately active (1) and inactive (2) [46]. Smoking was evaluated using three questions and the following groups were formed; ex-smoker/never smoked, occasional smoker (five to six days a week or occasionally) and smoker (daily smoking). Alcohol consumption was evaluated as the average consumption during the past year. Grams of pure alcohol per day (g/day) were calculated on the basis of frequency of alcohol use (daily to once a year or never), the usual amount of each alcoholic beverage per drinking occasion and the alcohol content (vol %) of each beverage (beer/cider/long-drink, light wine, table wine, and spirits) [37]. The participants were classified into quartile groups on the basis of their consumption of pure alcohol (g) per one day. The groups were scored 0 to 2 (0 being the lowest quartile, 1 being the 2^{nd} and 3^{rd} quartile, 2 being the highest quartile). Stress-related eating and drinking was measured by one item of the Ways of Coping Checklist [47-48]. Participants recalled the most stressful matter, event or situation that they had experienced during the past month. Then they evaluated whether and to what extend they tried to make themselves feel better by eating, drinking, using medication, etc.: did not use at all, used somewhat and used quite a bit or a great deal [37]. The groups were scored 0 (did not use at all), 1 (used somewhat) to 2 (used quite a bit or a great deal). The scores of all health behaviours were summed and divided into three groups (healthy, average and unhealthy) on the basis of tertile cut-off values.

Work history was elicited by a questionnaire at the ages of 31 and 46, using a seven-point scale: 1) employed continuously, 2) mainly long-term employment periods and temporary unemployment, 3) both long-term and short-term employment periods and temporary unemployment, 4) mainly short-term employment periods, but more employment than unemployment, 5) mainly short-term employment periods and more unemployment than employment , 6) most of my employment periods have been arranged by the governmental support system, 7) I have never been in gainful employment. The responses were dichotomized: 0: always at work (1), 1: other (2-7).

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics 20 and SAS Software (version 9.4, SAS Institute Inc., Cary, NC, USA). First the analyses were stratified by gender and then by physically strenuous work at the age of 46. We calculated the prevalence of obesity at the ages of 31 and 46, the prevalence ratio and 95% confidence intervals (95% CI) of obesity, and the mean values and 95% CI of perceived work ability at the age of 46. Cross-tabulations were used to investigate associations between weight classes, changes in weight classes and perceived work ability at the age of 46. Log-binomial regression analysis was used to predict the relative risk of poor perceived work ability at the age of 46, adjusting for basic education, health behaviours and social support at 31 years. First, 31-year weight classes were used as explanatory factors. Second, changes in weight classes were used as explanatory factors to explain poor perceived work ability. Last, the analyses were stratified by physically strenuous work using changes in weight classes as explanatory factors. The last analyses were adjusted for basic education, health behaviours, social support at work, work history and physically strenuous work at 31 years.

The proportions of people with poor work ability, obesity, physically strenuous work and a work history of at least some unemployment at the age of 31 were somewhat higher among those who were excluded from the analyses due to nonparticipation at the age of 46 than among those who participated and were included in the analyses.

Results

The prevalence of obesity more than doubled among men and women [prevalence ratio and 95% CI; men 2.41 (2.06-2.82) and women 2.34 (2.02-2.70)] from 31 to 46 years (Table 1). Mean perceived work ability at the age of 46 was 8.21 (8.14-8.28) among men and 8.28 (8.22-8.34) among women. Among both genders, the proportion of poor work ability at the age of 46 was highest among those who were obese at 31 and/or 46 years (Table 1).

Predictors of poor perceived work ability at the age of 46

Logistic regression analyses revealed that among both genders, those who were overweight or obese at the age of 31 were at a significantly increased relative risk of poor perceived work ability at the age of 46 (Table 2). In addition, low level of basic education, unhealthy behaviours at 31 years, lack of social support at work at 31 years, and at least some unemployment during one's work history independently increased the risk of poor perceived work ability at 46 years among both genders.

Among both genders, those who were obese both at the age of 31 and 46, and those who became obese between the ages of 31 and 46 were at an increased relative risk of poor work ability at the age of 46 (Table 3). These analyses were controlled for basic education, health behaviours at 31, social support at work at 31, and work history.

To study if the effect of obesity differed according to physically strenuous work at 46, we performed stratified analyses (Table 4). Those who were obese at 31 and 46 years of age, and those who became obese between the ages of 31 and 46, were at an increased relative risk of poor perceived work ability at the age of 46 according to multivariate logistic regression analyses (Table 4). The analyses were adjusted for gender, basic education, health behaviours, social support at work, work history, and the physical strenuousness of work at the age of 31.

Discussion

This prospective cohort study indicated that obesity at the age of 31 and 46, and developing obesity between the ages of 31 and 46 increased the relative risk of poor perceived work ability in early midlife among those in low and high physically strenuous work. Furthermore, unhealthy behaviours and lack of social support at work at 31 years were independent predictors of poor work ability at the age of 46. These longitudinal results help to identify young workers who might benefit from the promotion of health and work ability at workplaces that aim to promote good work ability in later life.

This study showed that the prevalence of obesity more than doubled during the 15-year follow-up. This result is alarming from the view of extending working careers, since obesity is associated with poor work ability in midlife and increases the risk of diseases leading to preterm retirement. As obesity poses a risk of diminished work ability, multilevel actions are needed for the prevention of obesity, and the promotion of healthy behaviours remains a high priority. Effective strategies and actions, also including environment and policy changes, must be developed. Health promotion at schools and workplaces could be one possible strategy for preventing unhealthy behaviours and obesity among the working aged.Workplaces, with the help of occupational health services, should promote healthy behaviours especially among those in physically demanding trades. The promotion of work ability may be a motivator of weight loss and maintaining normal weight.

Whereas earlier studies have shown that physically demanding work decreases work ability [23], we hypothesized that obesity would increase the risk of poor work ability, especially among workers with physically strenuous work [22-25]. Our results did not support this hypothesis, but we observed that obesity increased the risk of poor work ability regardless of the amount of physically strenuous work. The observed RR ratio among those with physically strenuous work might be somewhat diluted due to the healthy worker effect; for example the selection bias differed according to the level of physically strenuous work and obesity status. Nevertheless, these results support giving the prevention of obesity a high priority.

This study is unique due to its prospective follow-up study design. It increases the understanding of the factors at the beginning of the working career that affect later work ability, and thus also the length of the working career. Most earlier studies have been cross-sectional, and any earlier longitudinal studies have covered only ageing workers, very young workers or only women in one occupation [1, 14-18, 19]. The participation rates of NFBC have generally been quite high, but due to nonresponses, the final number of subjects included in this study was only a small part of the whole cohort. Although some selection bias was present, it might have diluted the observed results regarding explanatory variables and poor work ability. Furthermore, the prevalence ratios of obesity were similar to those

observed in other Finnish population studies [49]. Thus, the results can be generalized and used in the promotion of work ability during the early years of working careers.

Most earlier studies on the associations between obesity and work ability have used the whole Work Ability Index (WAI). We used only one of its items – current perceived work ability compared to lifetime best– because it has been shown to strongly associate with the whole Work Ability Index and predicted mental and physical work strain in midlife and disability after retirement [24, 41-43, 50, 51]. Moreover, by using this, the number of subjects was higher than it would have been had we used the whole WAI.

Obesity may increase discrimination in job markets, and unemployment may be a risk for poor work ability and obesity [28, 52, 53]. In this study, both obesity and the history of unemployment independently increased the risk of poor work ability. Because obesity may increase discrimination at job markets, it may cause unemployment and that way obesity is able to complicate to become employed, and cut into pieces and shorten working careers. It is important to invest to promotion of health behaviour at every arena of living and by every authorities and actors. For example also student health care, labour force administration and social services are possible places to support good life style choices.

We were able to adjust the multivariate models with several covariates. Job strain and stress have been shown to modestly increase the risk of obesity [54, 55], and high mental work demands associate with poor work ability [23]. The mediators between job strain and obesity and work ability might be stress-related eating and drinking, and physical inactivity, which have an effect on work ability [20, 56-60]. In this study, we used unhealthy behaviours as a sumscore. As it was independently covariate, the effect of job strain was taken into account to some extent. We did not include job strain as a covariate in the analyses in order to maximize the number of included participants, and to avoid possible bias due to nonresponse to the sub-items of job strain.

Practical Implications

As obesity poses a risk of diminished work ability, multilevel actions are needed to promote work ability, prevent obesity and promote permanent weight loss among the obese. Workplaces, with the help of occupational health services, should promote healthy behaviours in order to prevent weight gain and unhealthy habits, especially among those in physically demanding trades. The promotion of work ability may be a motivator of weight loss and maintaining normal weight.

References

1. Tuomi K, Huuhtanen P, Nykyri E, Ilmarinen J. Promotion of work ability, the quality of work and retirement. *Occup Med*. 2001;51(5):318-24.
2. Sell L, Bültmann U, Rugulies R, Villadsen E, Faber A, Søgaard K. Predicting long-term sickness absence and early retirement pension from self-reported work ability. *Int Arch Occup Environ Health*. 2009;82(9):1133-8.
3. Kujala V, Tammelin T, Remes J, Vammavaara E, Ek E, Laitinen J. Work ability index of young employees and their sickness absence during the following year. *Scand J Work Environ Health*. 2006;32(1):75-84.
4. Alavinia SM1, van den Berg TI, van Duivenbooden C, Elders LA, Burdorf A. Impact of work-related factors, lifestyle, and work ability on sickness absence among Dutch construction workers. *Scand J Work Environ Health.* 2009;35(5):325-33.
5. Ng M, Fleming T, Robinson M, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet*. 2014;384(9945):766-81.
6. Neovius M, Kark M, Rasmussen F. Association between obesity status in young adulthood and disability pension. Int J Obes. 2008;32(8):1319-26.
7. Guh DP, Zhang W, Bansback N, Amarsi Z, Birmingham CL, Anis AH. The incidence of co-morbidities related to obesity and overweight: a systematic review and meta-analysis.BMC Public Health. 2009;25;9:88.
8. Robroek SJ, Reeuwijk KG, Hillier FC, Bambra CL, van Rijn RM, Burdorf A.The contribution of overweight, obesity, and lack of physical activity to exit from paid employment: a meta-analysis. Scand J Work Environ Health. 2013;39(3):233-40.
9. Roos E, Laaksonen M, Rahkonen O, Lahelma E, Lallukka T. Relative weight and disability retirement: a prospective cohort study. Scand J Work Environ Health. 2013;39(3):259-67.
10. Neovius K, Johansson K, Rössner S, Neovius M. Disability pension, employment and obesity status: a systematic review. Obes Rev. 2008;9(6):572-81.
11. Rissanen A, Heliövaara M, Knekt P, Reunanen A, Aromaa A, Maatela J.Risk of disability and mortality due to overweight in a Finnish population. BMJ. 1990;301(6756):835-7.
12. Månsson NO, Eriksson KF, Israelsson B, Ranstam J, Melander A, Råstam L. Body mass index and disability pension in middle-aged men--non-linear relations. Int J Epidemiol. 1996;25(1):80-5.

13. Roos E, Laaksonen M, Rahkonen O, Lahelma E, Lallukka T. Weight change and sickness absence-a prospective study among middle-aged employees. *Eur J Public Health.* 2015;25(2):263-7.
14. Pohjonen T.Age-related physical fitness and the predictive values of fitness tests for work ability in home care work. J Occup Environ Med. 2001;43(8):723-30.
15. Fischer FM, Borges FN, Rotenberg L, et al. Work ability of health care shift workers: What matters? *Chronobiol Int.* 2006;23(6):1165-79.
16. Yong M, Nasterlack M, Pluto RP, Elmerich K, Karl D, Knauth P.Is health, measured by work ability index, affected by 12-hour rotating shift schedules? *Chronobiol Int.* 2010;27(5):1135-48.
17. Bridger RS, Bennett AI. Age and BMI interact to determine work ability in seafarers. *Occup Med.* 2011;61(3):157-62.
18. Fischer FM1, Martinez MC. Individual features, working conditions and work injuries are associated with work ability among nursing professionals. *Work*. 2013;45(4):509-17.
19. Airila A, Hakanen J, Punakallio A, Lusa S, Luukkonen R. Is work engagement related to work ability beyond working conditions and lifestyle factors? *Int Arch Occup Environ Health.* 2012;85(8):915-25.
20. Laitinen J, Näyhä S, Kujala V. Body mass index and weight change from adolescence into adulthood, waist-to-hip ratio and perceived work ability among young adults. *Int J Obes.* 2005;29(6):697-702.
21. Flegal KM, Kit BK, Orpana H, Graubard BI. Association of all-cause mortality with overweight and obesity using standard body mass index categories: a systematic review and meta-analysis. *JAMA*. 2013;309(1):71-82.
22. Alavinia SM, van Duivenbooden C, Burdorf A.Influence of work-related factors and individual characteristics on work ability among Dutch construction workers. *Scand J Work Environ Health*. 2007;33(5):351-7.
23. van den Berg TI, Elders LA, de Zwart BC, Burdorf A. The effects of work-related and individual factors on the Work Ability Index: a systematic review. *Occup Environ Med.* 2009;66(4):211-20.
24. Gould R, Ilmarinen J, Järvisalo J, Koskinen S., Dimensions of work ability: results of the Health 2000 Survey. Waasa Graphics Oy, Vaasa 2008. 65-79.
25. Ilmarinen J, Tuomi K, Klockars M. Changes in the work ability of active employees over an 11-year period. *Scand J Work Environ Health.* 1997;23 Suppl 1:49-57.
26. Claessen H, Arndt V, Drath C, Brenner H. Overweight, obesity and risk of work disability: a cohort study of construction workers in Germany. *Occup Environ Med*. 2009;66(6):402-9.

27. Aittomäki A, Lahelma E, Roos E. Work conditions and socioeconomic inequalities in work ability. *Scand J Work Environ Health*. 2003;29(2):159-65.

28. Laitinen J, Power C, Ek E, Sovio U, Järvelin MR. Unemployment and obesity among young adults in a northern Finland 1966 birth cohort. *Int J Obes Relat Metab Disord*. 2002;26(10):1329-38.

29. Ball K, Crawford D. Socioeconomic status and weight change in adults: a review. *Soc Sci Med*. 2005;60(9):1987-2010.

30. McLaren L. Socioeconomic status and obesity. *Epidemiol Rev*. 2007;29:29-48.

31. Novak M, Ahlgren C, Hammarström A. A life-course approach in explaining social inequity in obesity among young adult men and women. *Int J Obes.* 2006;30(1):191-200.

32. Lahelma E, Laaksonen M, Aittomäki A. Occupational class inequalities in health across employment sectors: the contribution of working conditions. *Int Arch Occup Environ Health*. 2009;82(2):185-90.

33. Kaikkonen R, Rahkonen O, Lallukka T, Lahelma E. Physical and psychosocial working conditions as explanations for occupational class inequalities in self-rated health. *Eur J Public Health*. 2009;19(5):458-63.

34. Taskila T, Martikainen R, Hietanen P, Lindbohm ML. Comparative study of work ability between cancer survivors and their referents. *Eur J Cancer*. 2007;43(5):914-20.

35. Jääskeläinen A1, Kaila-Kangas L, Leino-Arjas P, et al. Psychosocial factors at work and obesity among young finnish adults: a cohort study. *J Occup Environ Med.* 2015;57(5):485-92.

36. Kaleta D, Makowiec-Dabrowska T, Jegier A. Lifestyle index and work ability. *Int J Occup Med Environ Health*. 2006;19(3):170-7.

37. Laitinen J, Ek E, Sovio U. Stress-related eating and drinking behavior and body mass index and predictors of this behavior. *Prev Med.* 2002;34(1):29-39.

38. Rantakallio P. Groups at risk in low birth weight infants and perinatal mortality. *Acta Paediatr Scand*. 1969;193:Suppl 193:1+.

39. Rantakallio P.The longitudinal study of the northern Finland birth cohort of 1966. *Paediatr Perinat Epidemiol.* 1988;2(1):59-88.

40. Rantakallio P. Family background to and personal characteristics underlying teenage smoking. Background to teenage smoking. *Scand J Soc Med*. 1983;11(1):17-22.

41. Ahlstrom L, Grimby-Ekman A, Hagberg M, Dellve L. The work ability index and single-item question: associations with sick leave, symptoms, and health--a prospective study of women on long-term sick leave. *Scand J Work Environ Health*. 2010;36(5):404-12.

42. El Fassi M, Bocquet V, Majery N, Lair ML, Couffignal S, Mairiaux P. Work ability assessment in a worker population: comparison and determinants of Work Ability Index and Work Ability score. *BMC Public Health.* 2013;13:305. doi: 10.1186/1471-2458-13-305.

43. Ilmarinen J, Tuomi K. Past, present and future of work ability*. People and Work Research Reports*, 2004;65:1-25.

44. Tuomi K, Ilmarinen J, Jahkola A, Katajarinne L, Tulkki A. Work Ability Index. Helsinki: Finnish Institute of Occupational Health 2006. Occupational health care No19, 2nd revised edition. Helsinki: Finnish Institute of Occupational Health. 2006.

45. Ahlstrom L, Hagberg M, Dellve L. Workplace rehabilitation and supportive conditions at work: a prospective study. *J Occup Rehabil*. 2013;23(2):248-60.

46. Tammelin T, Näyhä S, Hills AP, Järvelin MR.Adolescent participation in sports and adult physical activity. *Am J Prev Med*. 2003;24(1):22-8.

47. Folkman S, Lazarus RS. If it changes it must be a process: study of emotion and coping during three stages of a college examination. *J Pers Soc Psychol*. 1985;48(1):150-70.

48. Lazarus RS, Folkman S. Stress, Appraisal, and Coping. New York: Springer Publishing Company, 1984.

49. Borodulin K, Vartiainen E, Peltonen M, et al. Forty-year trends in cardiovascular risk factors in Finland. *Eur J Public Health*. 2015;25(3):539-46.

50. von Bonsdorff ME, Kokko K, Seitsamo J, et al.Work strain in midlife and 28-year work ability trajectories. *Scand J Work Environ Health.* 201;37(6):455-63.

51. von Bonsdorff MB1, Seitsamo J, Ilmarinen J, Nygård CH, von Bonsdorff ME, Rantanen T. Work ability in midlife as a predictor of mortality and disability in later life: a 28-year prospective follow-up study. *CMAJ*. 2011;183(4):E235-42.

52. Puhl R, Brownell KD. Bias, discrimination, and obesity. *Obes Res*. 2001;9(12):788-805.

53. Puhl RM, Heuer CA. The stigma of obesity: a review and update. *Obesity*, 2009;17(5)941-964.

54. Solovieva S, Lallukka T, Virtanen M, Viikari-Juntura E. Psychosocial factors at work, long work hours, and obesity: a systematic review. *Scand J Work Environ Health*. 2013;39(3):241-58.

55. Wardle J, Chida Y, Gibson EL, Whitaker KL, Steptoe A. Stress and adiposity: a meta-analysis of longitudinal studies. *Obesity*. 2011;19(4):771-8.

56. Siegrist J, Rödel A. Work stress and health risk behavior. *Scand J Work Environ Health.* 2006;32(6):473-81.

57. Fransson EI, Heikkilä K, Nyberg ST, et al. Job strain as a risk factor for leisure-time physical inactivity: an individual-participant meta-analysis of up to 170,000 men and women: the IPD-Work Consortium. *Am J Epidemiol*. 2012;176(12):1078-89.

58. Cappuccio FP, Taggart FM, Kandala NB, et al. Meta-analysis of short sleep duration and obesity in children and adults. *Sleep*. 2008;31(5):619-26.

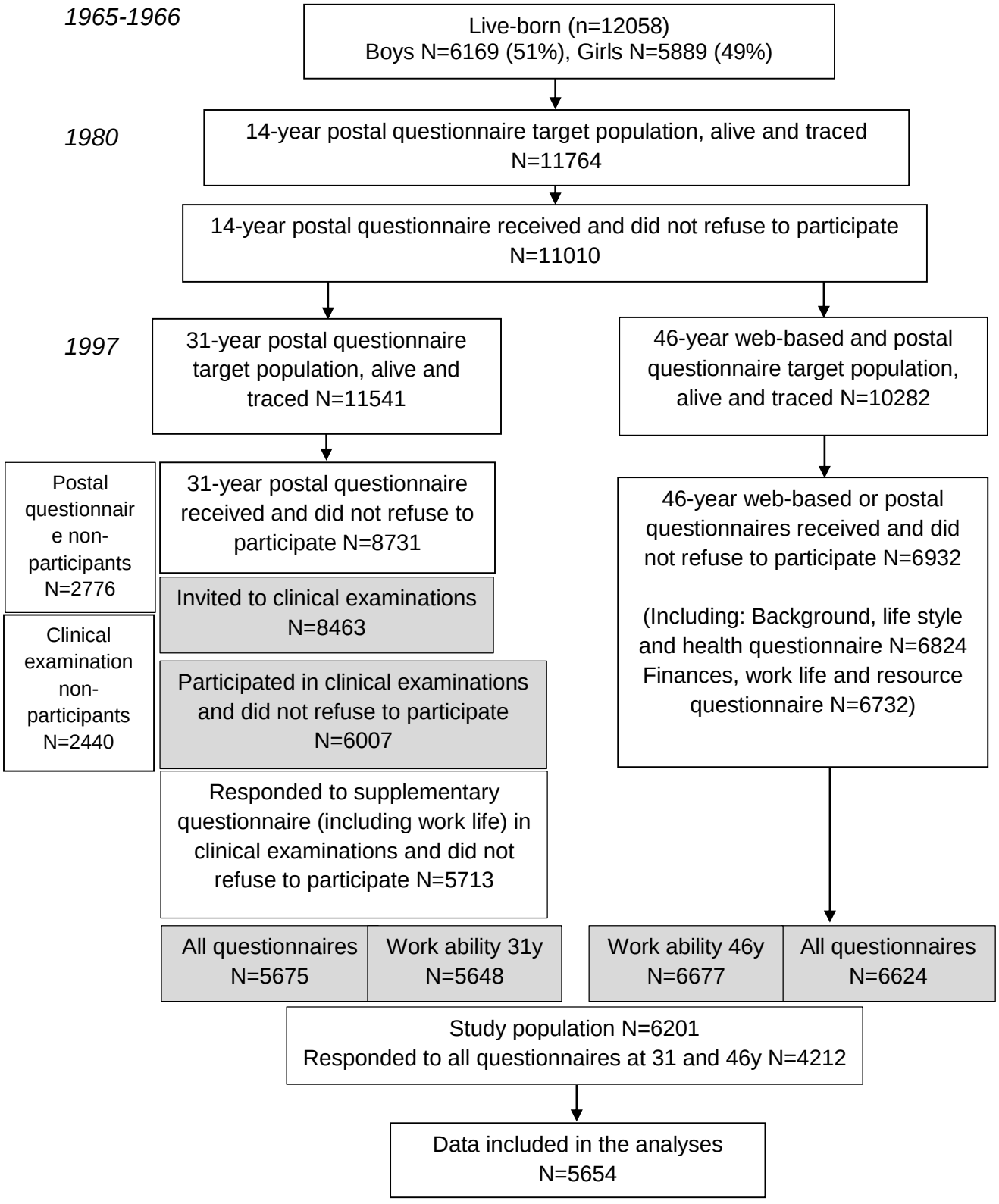
59. van den Berg TI, Alavinia SM, Bredt FJ, Lindeboom D, Elders LA, Burdorf A. The influence of psychosocial factors at work and life style on health and work ability among professional workers. *Int Arch Occup Environ Health*. 2008;81(8):1029-36.

60. Salo P, Oksanen T, Sivertsen B, et al. Sleep disturbances as a predictor of cause-specific work disability and delayed return to work. *Sleep*. 2010;33(10):1323-31.

Legend for the figure:

Figure 1. Flow chart

Figure


1965-1966
Live-born (n=12058)
Boys N=6169 (51%), Girls N=5889 (49%)
1980
14-year postal questionnaire target population, alive and traced N=11764
14-year postal questionnaire received and did not refuse to participate N=11010
1997
31-year postal questionnaire target population, alive and traced N=11541
46-year web-based and postal questionnaire target population, alive and traced N=10282
Postal questionnaire non-participants N=2776
31-year postal questionnaire received and did not refuse to participate N=8731
46-year web-based or postal questionnaires received and did not refuse to participate N=6932
(Including: Background, life style and health questionnaire N=6824 Finances, work life and resource questionnaire N=6732)
Invited to clinical examinations N=8463
Clinical examination non-participants N=2440
Participated in clinical examinations and did not refuse to participate N=6007
Responded to supplementary questionnaire (including work life) in clinical examinations and did not refuse to participate N=5713
All questionnaires N=5675
Work ability 31y N=5648
Work ability 46y N=6677
All questionnaires N=6624
Study population N=6201
Responded to all questionnaires at 31 and 46y N=4212
Data included in the analyses N=5654

Table

Table 1. Frequencies of BMI classes and BMI class change between ages 31 and 46 years and their associations with poor perceived work ability (WA) at 46 years.

		Men (n=2599)		Women (n=3055)	
		All (%)	Poor WA (0-7)	All (%)	Poor WA (0-7)
BMI class 31 y	underw. or normal weight	1359 (52.3)	226 (16.6)	2194 (71.8)	326 (14.9)
	overweight	1035 (39.8)	219 (21.2)	615 (20.1)	122 (19.8)
	obese	205 (7.9)	66 (32.2)	246 (8.1)	76 (30.9)
p-value*			<0.001		<0.001
BMI class 46 y	underw. or normal weight	829 (31.9)	128 (15.4)	1495 (48.9)	201 (13.4)
	overweight	1282 (49.3)	228 (17.8)	979 (32.0)	161 (16.4)
	obese	488 (18.8)	155 (31.8)	581 (19.0)	162 (27.9)
p-value			<0.001		<0.001
BMI change 31 to 46 y	underweight or normal weight at 46 y	829 (31.9)	128 (15.4)	1495 (48.9)	201 (13.4)
	overweight at 46 y	1282 (49.3)	228 (17.8)	979 (32.0)	161 (16.4)
	became obese	313 (12.0)	94 (30.0)	363 (11.9)	91 (25.1)
	always obese	175 (6.7)	61 (34.9)	218 (7.1)	71 (32.6)
p-value*			<0.001		<0.001
Basic education	matriculation examination	882 (33.9)	112 (12.7)	1651 (54.0)	215 (13.0)
	no matriculation examination	1716 (66.1)	398 (23.2)	1404 (46.0)	309 (22.0)
p-value			<0.001		<0.001
Health behaviors at 31 y	healthy	996 (40.0)	143 (14.4)	1245 (42.5)	189 (15.2)
	average	891 (35.8)	180 (20.2)	1141 (39.0)	188 (16.5)
	unhealthy	602 (24.2)	161 (26.7)	542 (18.5)	124 (22.9)
p-value			<0.001		<0.001
Social support at work 31 y	quite a lot /a great deal	893 (35.5)	135 (15.1)	1112 (38.2)	144 (12.9)
	some	683 (27.1)	117 (17.1)	724 (24.9)	116 (16.0)
	not at all / slightly	941 (37.4)	236 (25.1)	1076 (37.0)	221 (20.5)
p-value			<0.001		<0.001
Work history 46 y	mostly at work	1457 (56.2)	215 (14.8)	1570 (51.9)	203 (12.9)
	at least some unemployment	1134 (43.8)	290 (25.6)	1455 (48.1)	312 (21.4)
p-value			<0.001		<0.001

*Chi-Square test to predict differences between groups.

Table

Table 2. Logistic regression models to predict poor work ability (WA 0-7) at 46 years by 31-year weight classes among men (n=2417) and women (n=2942).

			Crude		Multivariate model†	
		Cases/N	RR	95% CI	RR	95% CI
Men						
BMI class 31 y	normal weight	211/1271	1.00		1.00	
	overweight	199/767	1.24	1.04, 1.48	1.19	1.01-1.41
	obese	58/188	1.86	1.45, 2.38	1.55	1.22-1.97
Basic education	matriculation examination	103/828	1.00		1.00	
	no matriculation examination	365/1597	1.84	1.50, 2.25	1.53	1.25-1.88
Health behaviours 31 y	healthy	141/974	1.00		1.00	
	average	173/863	1.38	1.13, 1.70	1.28	1.05-1.56
	unhealthy	154/588	1.81	1.47, 2.22	1.54	1.26-1.89
Social support at work 31 y	a great deal / quite a bit	128/862	1.00		1.00	
	some	116/662	1.18	0.94, 1.49	1.11	0.89-1.39
	not at all / slightly	224/901	1.67	1.38, 2.04	1.55	1.28-1.88
Work history	mostly at work	203/1378	1.00		1.00	
46 y	at least some unemployment	265/1047	1.72	1.46-2.02	1.53	1.30-1.80
Women						
BMI class 31 y	normal weight	282/2015	1.00		1.00	
	overweight	112/561	1.43	1.17, 1.74	1.35	1.11-1.64
	obese	67/227	2.11	1.68, 2.65	1.82	1.45-2.28
Basic education	matriculation examination	193/154	1.00		1.00	
	no matriculation examination	268/1258	1.71	1.44, 2.02	1.47	1.23-1.74
Health behaviours 31y	healthy	172/1184	1.00		1.00	
	average	170/1097	1.07	0.88, 1.30	1.04	0.86-1.26
	unhealthy	119/522	1.57	1.27, 1.94	1.31	1.06-1.61
Social support at work 31y	a great deal / quite a bit	137/1071	1.00		1.00	
	some	114/699	1.27	1.01, 1.60	1.22	0.98-1.53
	not at all / slightly	210/1033	1.59	1.30, 1.94	1.37	1.13-1.67
Work history	mostly at work	185/1480	1.00		1.00	
46 y	at least some unemployment	276/1323	1.67	1.41-1.98	1.44	1.21-1.71

†Multivariate analysis including basic education, health behaviours, social support at work and work history

Table

Table 3. Logistic regression models to predict poor work ability (WA 0-7) at 46 years by weight class from 31 to 46y among men (n=2425) and women (n=2803)

			Crude		Multivariate model†	
Men		Cases/N	RR	95% CI	RR	95% CI
BMI from 31 to 46 y	normal weight	118/782	1.00		1.00	
	overweight	211/1188	1.18	0.96-1.45	1.15	0.94-1.40
	became obese	86/294	1.94	1.52-2.47	1.68	1.32-2.13
	always obese	53/161	2.18	1.66-2.88	1.77	1.35-2.31
Women						
BMI from 31 to 46 y	normal weight	176/1378	1.00		1.00	
	overweight	140/893	1.23	1.00-1.51	1.21	0.99-1.48
	became obese	83/332	1.96	1.55-2.47	1.79	1.43-2.25
	always obese	62/200	2.43	1.89-3.11	2.08	1.62-2.66

† Adjusted with basic education, health behaviours at the age 31 y, social support at work at the age of 31 y and work history 46 y

Table

Table 4. Logistic regression models to predict poor work ability (WA 0– 7) at 46 years by weight classes at 46 among those whose work is less physically strenuous (lower half of the median, n=1360) and whose work is more physically strenuous (higher half of the median n=1310) at the age of 46.

			Model 1		Model 2	
		Cases/N	RR	95 % CI	RR	95 % CI
Lower level of physical work strain at 46y						
BMI 46y	normal w.	40/540	1.00		1.00	
	overweight	61/577	1.40	0.95-2.07	1.30	0.89-1.92
	obese	52/244	2.84	1.92-4.18	2.37	1.60-3.53
Higher level of physical work strain at 46y						
BMI 46y	normal w.	69/508	1.00		1.00	
	overweight	93/559	1.20	0.90-1.60	1.22	0.92-1.63
	obese	64/239	1.97	1.45-2.66	1.95	1.45-2.63

Model 1 Adjusted with gender
Model 2 Adjusted with gender and basic education, health behaviours and social support at work, physical strenuousness of work at the age of 31y and working history at 46y

Clinical Significance:

Long-term obesity and developing obesity before midlife poses a risk of diminished work ability. To prevent dropping out from working life, which has ill consequences at both the individual and societal level, multilevel actions are needed: policies and environmental solutions to promote healthy eating and physical activity, health promotion at workplaces, and focus on maintaining normal weight at all appointments in the health care sector and occupational health care. The promotion of work ability may be a motivator for weight loss and maintaining normal weight.