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PHYSICAL AND MENTAL HEALTH FACTORS ASSOCIATE WITH WORK ENGAGEMENT AMONG FINNISH FEMALE MUNICIPAL EMPLOYEES: A CROSS-SECTIONAL STUDY

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ABSTRACT

OBJECTIVES: Work engagement is related to mental health, but studies of physical health's association with work engagement are scarce. This study aims to evaluate the relationship between physical health, psychosocial risk factors and work engagement among Finnish women at municipal work units.

METHODS: A cross-sectional study conducted in 2014 among 726 female employees from ten municipal work units of the city of Pori, Finland. Work engagement was assessed with a 9-item Utrecht Work Engagement Scale and physical health (smoking, body mass index, physical activity, diet, cholesterol, blood pressure and glucose) with the American Heart Association's concept of ideal cardiovascular health (CVH). Psychosocial risk factors (social isolation, stress, depressive symptoms, anxiety, hostility, and type D personality) were included as core questions suggested by 2012 European guidelines on cardiovascular disease prevention.

RESULTS: Of the study subjects, 25.2% (183/726) had favorable 5-7 CVH metrics. The sum of CVH metrics, healthy diet and physical activity at goal associated with work engagement. In subjects without psychosocial risk factors (36.7%, 266/726), work engagement was high and stable across the range of the sum of ideal CVH metrics. Even one of the measured psychosocial risk factors could lower the level of work engagement regardless of the sum of ideal CVH metrics.

CONCLUSIONS: Our results suggest that both physical and mental health factors have significant impact on work engagement. However, even one psychosocial risk factor has potential to decrease work engagement regardless of the level of classic cardiovascular risk factors.

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Strenghts and limitations of this study

- This study uses objective indicators of physical health
- Several aspects of life in many occupational groups were took into account, which enables us to generalize results to young and middle-aged female employees
- The causality cannot be determined due to the cross-sectional nature of our study
- The exact participation rate for the study is impossible to say, because we cannot know how many of the employees really got or read the invitation e-mail

Keywords: physical health, mental health, ideal cardiovascular health, work engagement, psychosocial risk factors, women

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Introduction

Work engagement is a positive psychological construct, which is defined as ”a positive, fulfilling, work-related state of mind that is characterized by vigor, dedication and absorption” (1). Work engagement is positively related to perceived health status (2) and negatively with psychological distress, physical complaints (3-5) and depressive symptoms (6-9). Psychosocial factors also have potential to affect the onset or progression of cardiovascular disease (CVD) (10). European Guidelines on CVD prevention in clinical practice suggests use of core questions within the physicians’ clinical interview as a preliminary assessment of psychosocial risk factors (10).

CVD is a major health burden explaining 50% of all causes of death of working population globally (11), reducing work ability and leading to premature workforce loss (12). Unfortunately, in women coronary event rates have not decreased during the last two decades (13-17) and women-focused nuances are needed in the prevention of CVD. American Heart Association (AHA) has created a concept of ideal cardiovascular health (CVH), which aims to reduce CVD mortality and improve cardiovascular risk factors in the US population by 20% by 2020 (18). Ideal CVH is defined as the simultaneous presence of favorable health behaviors (nonsmoking, ideal body mass index, physical activity at goal, healthy diet) and health factors at ideal level (total cholesterol, blood pressure, fasting plasma glucose) (18).

Identifying factors influencing work engagement and enhancing healthy lifestyle is a wishful strategy for prevention of CVD. Although work plays a prominent role in our lives, studies of the health-enhancing potential of work engagement are scarce. This study aims to evaluate the

relationship between physical health, psychosocial risk factors and work engagement among Finnish women at municipal work units.

Materials and Methods

Participants and study design

PORTAAT (PORi To Aid Against Threats) is a longitudinal study conducted among employees of the city of Pori (83 497 inhabitants in 2014) in South-Western Finland. The study population comprised workers from ten work units, which were selected by the chief of the municipal welfare unit of Pori. Invitation and study information letters were sent to the employees as an email attachment by the managers of the work units. Information events were also organized for employees. There were no exclusion criteria. Altogether 836 employees (104 males, 732 females) consented to participate in the PORTAAT study. In this paper, we analyzed the data of 726 female employees having completed the work engagement questionnaire and working in libraries (n=22), museums (n=33), technical management (n=80), social services (=195), and health care units (n=396).

Measures

Work-related measures

Work engagement was measured with the 9-item Utrecht Work Engagement Scale (UWES-9) (19). UWES-9 consists of three sub-scales; vigor, dedication and absorption, which were rated on 7-point Likert scale ranging from 0 (never) to 6 (daily). Items were summed and divided by the number of items in each scale. The higher each item was rated the higher the overall work engagement. The Finnish values for total work engagement are <1.44 (very low), 1.44-3.43 (low), 3.44-4.53 (moderate), 4.54-5.30 (high) and 5.31-6.00 (very high) (20).

We assessed the worker´s ability to participate in work with the question “what is your current work ability compared to lifetime best?”. This first item of widely used Work Ability Index (21) is named

Work Ability Score (WAS) and has a 0–10 response scale, where 0 represents "completely unable to work" and 10 "work ability at its best". Reference values for WAS are suggested as for Work Ability Index; poor (0–5 points), moderate (6-7), good (8-9), excellent (10) (22).

Occupational status, working hours per week and the role of shift work in current work were asked with self-administrated questionnaires. Financial satisfaction was assessed with the question "I have to spare expenditures" (yes or no).

Ideal cardiovascular health metrics

Smoking status was assessed by a questionnaire. Nonsmoking was defined as having never smoked or having quit smoking >12 months ago.

Height and weight were measured by a study nurse with subjects in standing position without shoes and outer garments. Weight was measured to the nearest 0,1kg with calibrated scales and height to the nearest 0,5cm with a wall-mounted stadiometer. Body mass index (BMI) was calculated as weight (kg) divided by the square of height (m^2). Ideal BMI was <25.0 kg/m^2.

Physical activity was assessed using a questionnaire that asked the frequency and duration of leisure time and commuting activities in a typical week. Ideal physical activity was defined as engaging in ≥150 minutes per week of moderate intensity activities or ≥75 minutes per week of vigorous intensity activities or ≥150 minutes per week of moderate + vigorous intensity activities (18).

Information of diet was collected with a food-frequency questionnaire. Daily consumption of fruits, vegetables, whole grains, unsaturated dietary fats and white meat (poultry, fish) at least three times a week were considered as healthy diet. Intake of the ideal level of each dietary component was scored with one point, for a range of 0–5. The dietary CVH metric was categorized as ideal, if a dietary score of 4–5 was achieved (18).

Blood pressure was measured by a study nurse with an automatic validated blood pressure monitor with subjects in a sitting posture, after resting at least 5 minutes. In the subjects whose arm circumference was >32 cm, a larger cuff was used. Two readings taken at intervals of at least 2 minutes were measured, and the mean of these readings was used in the analysis. Ideal level was untreated blood pressure <120 mmHg systolic and <80 mmHg diastolic.

Laboratory tests were determined in blood samples which were obtained after at least 8 hours of fasting. Total cholesterol was measured enzymatically (Architect c4000/c8000). Ideal level was untreated total cholesterol <5.18 mmol/l. Glucose tolerance was measured with glycated hemoglobin (HbA1c) which was analyzed using High Performance Liquid Cromatography - method, HPLC, (Tosoh HLC-723G7 (G7)). The AHA metric uses fasting plasma glucose (<5.55 mmol/l) to determine normoglycemia, however we used HbA1c because its property of giving an indication of glycemia over several preceding weeks rather than at a single time point (23). Normoglycemia was defined as HbA1c <6.0% (<42 mmol/mol) (24).

The seven ideal CVH metrics were grouped to three categories: unfavorable (0-2 ideal CVH metrics), intermediate (3-4) and favorable (5-7) level of cardiovascular health (25).

Psychosocial risk factors

At the clinic, the study nurse assessed psychosocial risk factors by core questions suggested by the European 2012 guidelines on CVD prevention in clinical practice (10):

- Work and family stress: Do you have enough control over how to meet the demands at work? Is your reward appropriate for your effort? Do you have serious problems with your spouse?
- Social isolation: Are you living alone? Do you lack a close confidant?
- Depression: Do you feel down, depressed and hopeless? Have you lost interest and pleasure in

life?

- Anxiety: Do you frequently feel nervous, anxious, or on edge? Are you frequently unable to stop or control worrying?
- Hostility: Do you frequently feel angry over little things? Do you often feel annoyed about habits other people have?
- Type D personality: In general, do you often feel anxious, irritable, or depressed? Do you avoid sharing your thoughts and feelings with other people?

A ´yes´ answer to one or more of these questions was indicated as a likely psychosocial risk factor.

Other measures

With self-administrated questionnaires and medical records, information was gathered about diseases diagnosed by a physician, years of education, marital status (cohabiting or not) and quality of sleep (good or not good). Alcohol consumption was assessed with the 3-item Alcohol Use Disorders Identification Test (AUDIT-C) with a cutoff of 5 for harmful drinking (26).

Informed consent

The study protocol and consent forms were reviewed and approved by the Ethics Committee of the Hospital District of Southwest Finland. All participants provided written informed consent for the project and subsequent medical research.

Statistical analysis

Statistical significance for the hypothesis of linearity across categories of total work engagement and CVH metrics were evaluated by using the Cochran-Armitage test or generalized linear models (analysis of variance and logistic models). In the case of violation of the assumptions (e.g. non-

normality), a bootstrap-type test was used. All analyses were performed using STATA 14.1 (StataCorp LP, College Station, TX).

Results

We evaluated 726 female employees (mean age 48 ± 10 years). Table 1 shows the characteristics of the study subjects. Financial satisfaction, good quality of sleep and WAS associated positively with work engagement.

Of the study subjects, 25.2% (183/726) had 5-7 CVH metrics, 53.0% (385/726) had 3-4 metrics, and 21.8% (158/726) had 0-2 metrics at ideal level. The sum of ideal CVH metrics associated linearly with work engagement driven by the positive relationship of healthy diet and physical activity with work engagement (Table 1).

At least one psychosocial risk factor was reported by 63.3% (460/726) of the female employees. The prevalence of psychosocial risk factors was as follows: depressive symptoms 18.9% (137/726), anxiety 31.4% (228/726), hostility 20.9% (152/726), type D personality 26.3% (191/726), social isolation 17.5% (127/726), and stress 31.0% (225/726). The prevalence of any psychosocial risk factor decreased linearly with work engagement (Table 1).

Table 1. Characteristics of the study subjects according to the sum of work engagement

Figure1. Work engagement and its subscales according to the sum of ideal cardiovascular health metrics and prevalence of psychosocial risk factors among the female employees. Adjusted for age and education years.

Figure 1 shows that in subjects without psychosocial risk factors, total work engagement was high and stable (p-value for linearity 0.14) across the range of the sum of ideal CV health metrics. The

presence of even one psychosocial risk factor significantly impaired work engagement. Linearity between the presence of at least one psychosocial risk factor and work engagement was significant ($p < 0.001$) across the categories of the sum of ideal CVH metrics. The interaction between the presence of psychosocial risk factors and sum of ideal CVH metrics was not significant ($p = 0.79$).

Discussion

According to our study, physical health associates positively with work well-being driven by the positive relationship of healthy diet and physical activity on work engagement. However, even one of the measured psychosocial risk factors could lower the level of work engagement significantly regardless of the sum of ideal CVH metrics.

Our finding of the psychosocial risk factors influencing negatively on work engagement is in line with previous studies reporting that employees with a high level of work engagement have lower scores on stress, anxiety and depression (3, 5-9, 27). Especially vigor, characterized by ”energy, mental resilience, the willingness to invest one’s effort and persistence” (1) was linked to decreased depression and anxiety in a 2-year follow-up study (9). Due to technological developments, the nature of work in developed countries has become less physical but more demanding mentally and emotionally, as work pace and stress have increased (28). These changes in daily working life may contribute to adverse health effects, including mental health problems and body weight gain (28). However, work can also contribute in a positive way to mental health providing psychological development, social contacts, a purpose in life and increase in self-esteem and quality of life (28) as seen in a study where work engagement increased life satisfaction (8).

Compared to Finnish reference values (20) work engagement in our subjects was high and stable, even though women still tend to do most of the household work and childcare along with their jobs (29). Every fourth of our study subjects had 5-7 ideal CVH metrics, which is comparable to US (30). Willis et al. have estimated that individuals in midlife with 5–7 ideal CVH metrics exhibited 25% lower median annual non-CVD costs and 75% lower median CVD costs at old age than those with 0–2 ideal CVH metrics (25). Leijten et al have shown that work engagement is related to better physical health (31), which is in line with our finding of positive relationship between the sum of ideal CVH metrics and work engagement. However, it is unclear which efforts could increase work

engagement. Enhancing physical activity and fruit intake did not improve work engagement in a work place health promotion program (32), even though these were the ideal CVH metrics associated with work engagement in the present study.

In our study subjects, a linear increase in WAS was observed with rising work engagement (7.2 vs 8.8). This supports previous studies showing that work engagement has a positive influence on work ability (33-35). Work ability is the degree to which a worker, given his/her health, is physically and mentally able to cope with the demands at work (36). Work engagement is more dependent on mental aspects, whereas work ability comprises also physical condition.

Our finding of increasing quality of sleep with rising work engagement is established also by Hallberg et al. (6), who showed that poor sleep hygiene decreases work engagement. Financial satisfaction also associated with better work engagement in our study subjects.

We acknowledge some limitations of the study. The causality of work engagement with psychosocial risk factors or lifestyle factors cannot be determined due to the cross-sectional nature of our study. A common source bias might explain the relationship with work engagement and mental health, because the construct of work engagement resembles more mental health than the construct of physical health. A possible ”healthy worker effect” (37) can emerge, when subjects out of workforce were not studied. Exact participation rate for the study is impossible to say, because we cannot know how many of the employees really got or read the invitation e-mail. For psychosocial risk factors we used core questions instead of clinically diagnostic questionnaires. However, giving an affirmative answer to either one of the two core questions on depression used in the present study, has been shown to be as effective as using a longer screening instruments (38). Also the single-item question, WAS, is proved to have a strong association with the Work Ability Index and to be trustworthy in evaluating work ability (39).

Strengths of the study are that we could take into account several aspects of life in many occupational groups, which enables us to generalize results to young and middle-aged female employees. Anthropologic measures were conducted by trained medical staff, and objective indicators of physical health were used.

Conclusions

Our results suggest that both physical and mental health factors have significant impact on work engagement. However, even one psychosocial risk factor has potential to decrease work engagement regardless of the level of classic cardiovascular risk factors. Longitudinal studies are needed to confirm the direction of these associations.

Declaration of conflicting interests:

The authors declare that there are no conflicts of interest.

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Author contributions:

VV, HK and PK contributed to the conception or design of the work, and to the acquisition, analysis, or interpretation of data for the work. VV and PK drafted the manuscript. All authors critically revised the manuscript and gave final approval and agree to be accountable for all aspects of work ensuring integrity and accuracy.

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Table 1. Characteristics of the study subjects according to the sum of work engagement

Variables	Total work engagement				P-value*	
	Low (≤3.43) n=59	Moderate (3.44-4.53) n=151	High (4.54-5.30) n=276	Very high (>5.30) n=240	Crude	Adjusted **
Age, mean (SD)	47 (11)	48 (9)	47 (10)	49 (9)	0.53	..
Education years, mean (SD)	14.0 (2.5)	14.0 (2.6)	14.0 (2.7)	13.7 (2.8)	0.28	..
Financial satisfaction, n (%)	27 (46)	85 (56)	175 (63)	167 (70)	<0.001	<0.001
Marital status, cohabiting, n (%)	43 (73)	111 (74)	231 (84)	180 (75)	0.59	0.55
Good quality of sleep, n (%)	36 (61)	103 (68)	196 (71)	181 (75)	0.019	0.016
AUDIT-C, mean (SD)	2.9 (2.0)	2.9 (1.7)	3.1 (1.6)	2.7 (1.8)	0.55	0.59
Working hours, hours/week, mean (SD)	41.1 (4.0)	41.2 (3.6)	41.4 (3.9)	41.9 (4.2)	0.12	0.16
Shift work, n (%)	20 (34)	55 (36)	85 (31)	71 (30)	0.20	0.12
WAS, (NRS), mean (SD)	7.2 (1.7)	7.6 (1.4)	8.2 (1.0)	8.8 (0.9)	<0.001	<0.001
Sum of ideal cardiovascular health metrics, n (%)					0.076	0.023
Unfavorable (0-2)	11 (19)	39 (26)	59 (21)	49 (20)		

Intermediate (3-4)	37 (63)	80 (53)	148 (54)	120 (50)		
Favorable (5-7)	11 (19)	32 (21)	69 (25)	71 (30)		
Ideal cardiovascular health metrics, n (%)						
Nonsmoking	48 (82)	142 (94)	237 (86)	208 (87)	0.58	0.34
Body mass index <25.0 kg/m^2	30 (51)	63 (42)	117 (42)	87 (36)	0.050	0.070
Physical activity at goal	21 (36)	48 (32)	110 (40)	111 (46)	0.008	0.006
Healthy diet	16 (27)	45 (30)	90 (33)	107 (45)	<0.001	0.001
Untreated blood pressure <120/80mmHg	12 (20)	23 (15)	52 (19)	50 (21)	0.39	0.22
Untreated total cholesterol <5.18mmol/l	26 (44)	61 (40)	121 (44)	111 (46)	0.39	0.23
Untreated HbA1c <6.0% (42 mmol/mol)	54 (92)	139 (92)	263 (95)	215 (90)	0.43	0.58
Any psychosocial risk factor, n (%)	50 (85)	107 (71)	169 (61)	134 (56)	<0.001	<0.001
Depressive symptoms	25 (42)	38 (25)	46 (17)	28 (12)	<0.001	<0.001
Anxiety	31 (53)	57 (38)	83 (30)	57 (24)	<0.001	<0.001
Hostility	23 (39)	34 (23)	57 (21)	38 (16)	<0.001	<0.001

Type D personality	30 (51)	48 (32)	67 (24)	46 (19)	<0.001	<0.001
Social isolation	15 (25)	35 (23)	36 (13)	41 (17)	0.047	0.049
Stress	32 (54)	56 (37)	85 (31)	52 (22)	<0.001	<0.001

* P for linearity

* Adjusted for age and education years

Abbreviations: AUDIT-C; Alcohol Use Disorders Identification Test, WAS; work ability score, NRS; numeric rating scale, HbA1c; glycated hemoglobin

Figure 1. Work engagement and its subscales according to the sum of ideal cardiovascular health metrics and prevalence of psychosocial risk factors among the female employees. Adjusted for age and education years.

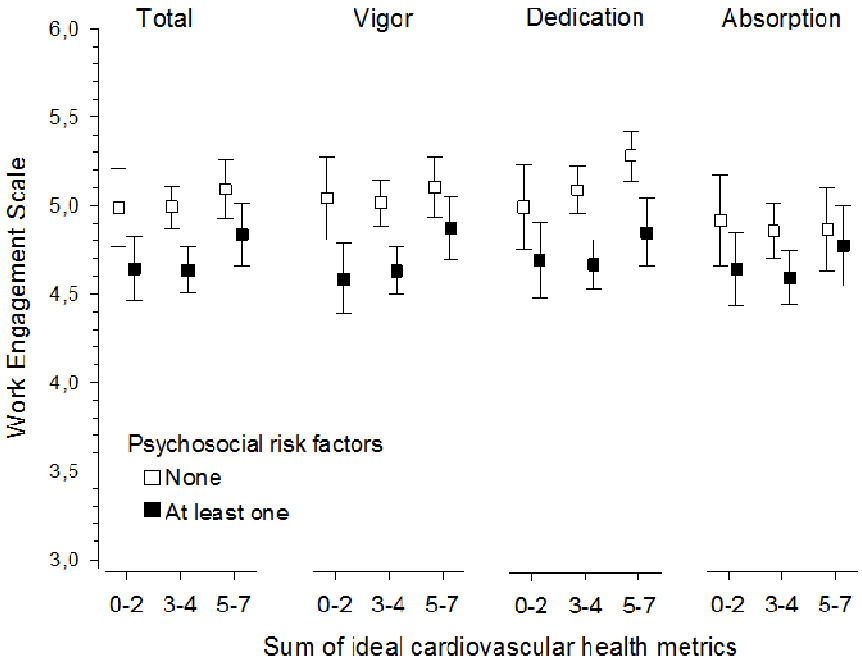
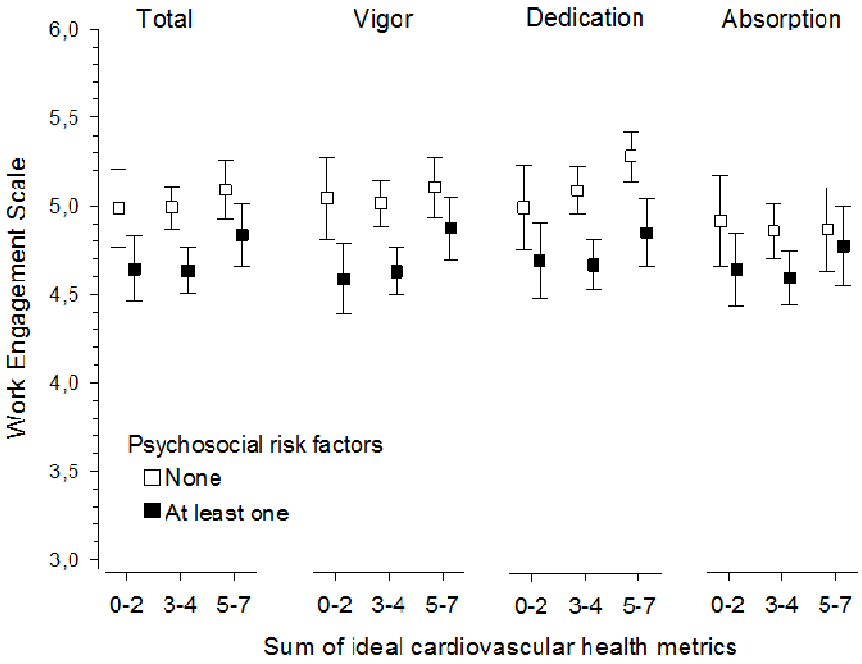


Figure 1. Work engagement and its subscales according to the sum of ideal cardiovascular health metrics and prevalence of psychosocial risk factors among the female employees. Adjusted for age and education years.



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PHYSICAL AND MENTAL HEALTH FACTORS ASSOCIATE WITH WORK ENGAGEMENT AMONG FINNISH FEMALE MUNICIPAL EMPLOYEES: A CROSS-SECTIONAL STUDY

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PHYSICAL AND MENTAL HEALTH FACTORS ASSOCIATE WITH WORK ENGAGEMENT AMONG FINNISH FEMALE MUNICIPAL EMPLOYEES: A CROSS-SECTIONAL STUDY

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ABSTRACT

OBJECTIVES: Work engagement is related to mental health, but studies of physical health's association with work engagement are scarce. This study aims to evaluate the relationship between physical health, psychosocial risk factors and work engagement among Finnish women at municipal work units.

METHODS: A cross-sectional study was conducted in 2014 among 726 female employees from ten municipal work units of the city of Pori, Finland. Work engagement was assessed with the 9-item Utrecht Work Engagement Scale. The American Heart Association's concept of ideal cardiovascular health (CVH) was used to define physical health (nonsmoking, body mass index <25.0 kg/m^2, physical activity at goal, healthy diet, total cholesterol <5.18 mmol/l, blood pressure <120/80 mmHg, normal glucose tolerance). Psychosocial risk factors (social isolation, stress, depressive symptoms, anxiety, hostility, and type D personality) were included as core questions suggested by 2012 European Guidelines on cardiovascular disease prevention.

RESULTS: Of the study subjects, 25.2% had favorable 5-7 CVH metrics. The sum of CVH metrics, healthy diet and physical activity at goal were positively associated with work engagement. In subjects without psychosocial risk factors (36.7%), work engagement was high and stable. Presence of even one psychosocial risk factor was associated with lower level of work engagement regardless of the sum of ideal CVH metrics.

CONCLUSIONS: Both physical and mental health factors have positive relationship with work engagement, whereas presence of even one psychosocial risk factor has negative association regardless of the level of classic cardiovascular risk factors.

Word count: 241/250

Strenghts and limitations of this study

- Anthropologic measurements were made by trained medical staff and laboratory tests were performed up-to-date
- Several aspects of life both at work and in leisure time could be taken into account in many occupational groups
- Any causality cannot be determined due to the cross-sectional nature of our study
- The exact participation rate for the study is impossible to say, because we cannot know how many of the employees really got or read the invitation e-mail

Keywords: physical health, mental health, ideal cardiovascular health, work engagement, psychosocial risk factors, women

PHYSICAL AND MENTAL HEALTH FACTORS ASSOCIATE WITH WORK ENGAGEMENT AMONG FINNISH FEMALE MUNICIPAL EMPLOYEES: A CROSS-SECTIONAL STUDY

Introduction

Cardiovascular disease (CVD) is a major health burden explaining 50% of all causes of death of working population globally (1), reducing work ability and leading to premature workforce loss (2). Unfortunately, in women coronary event rates have not decreased during the last two decades (3-7) and women-focused nuances are needed in the prevention of CVD.

The American Heart Association (AHA) has created a concept of ideal cardiovascular health (CVH), which aims to reduce CVD mortality and improve cardiovascular risk factors in the US population by 20% by 2020 (8). Ideal CVH is defined as the simultaneous presence of favorable health behaviors (nonsmoking, ideal body mass index, physical activity at goal, healthy diet) and health factors at ideal level (total cholesterol, blood pressure, fasting plasma glucose) (8). Psychosocial factors also have potential to affect the onset or progression of CVD. European Guidelines on CVD prevention in clinical practice emphasize that low socio-economic status, lack of social support, stress at work and in family life, depression, anxiety, hostility, and the type D personality can act as barriers to treatment adherence and efforts to improve lifestyle, as well as to promoting health and well-being in patients and populations (9).

Although work plays a prominent role in our lives, studies of the health-enhancing potential of work engagement are scarce. Work engagement is a positive psychological construct, which is defined as ”a positive, fulfilling, work-related state of mind that is characterized by vigor, dedication and absorption” (10). Work engagement is positively related to perceived health status (11) and negatively with psychological distress, physical complaints (12-14) and depressive

symptoms (15-18).

Identifying factors influencing work engagement and enhancing healthy lifestyle is a wishful strategy for prevention of CVD. This study aims to assess cardiovascular health, psychosocial factors, and work engagement among female employees at municipal work units. We hypothesize that cardio-protective factors have positive relationship with work engagement. More specifically, we hypothesize that the individual and the sum of CVH metrics would associate with work engagement. Furthermore, we wanted to examine whether the presence of a psychosocial risk factor would affect work engagement evaluated across the categories of CVH metrics.

Materials and Methods

Participants and study design

PORTAAT (PORi To Aid Against Threats) is a longitudinal study conducted among employees of the city of Pori (83 497 inhabitants in 2014) in South-Western Finland. The study population comprised workers from ten work units, which were selected by the chief of the municipal welfare unit of Pori. The main selection criteria was that the work unit had not been involved in other health promoting program than routine occupational health care during the past years. Invitation and study information letters were sent to the employees as an email attachment by the managers of the work units. Information events were also organized for employees. There were no exclusion criteria. Altogether 836 employees (104 males, 732 females) consented to participate in the PORTAAT study. In this cross-sectional paper, we analyzed the data of 726 female employees working in libraries (n=22), museums (n=33), technical management (n=80), social services (=195), and health care units (n=396), and who had completed the work engagement questionnaire.

Measures

Work-related measures

Work engagement was measured with the 9-item Utrecht Work Engagement Scale (UWES-9) (19). UWES-9 consists of three subscales; vigor, dedication and absorption, which were scored on 7-point Likert scale ranging from 0 (never) to 6 (daily). The mean subscale score was computed by adding the scores on the particular scale and dividing the sum by the number of items of the subscale involved. A similar procedure was followed for the total score. The higher each item was rated the higher the overall work engagement. The Finnish values for total work engagement are <1.44 (very low), 1.44-3.43 (low), 3.44-4.53 (moderate), 4.54-5.30 (high) and 5.31-6.00 (very high) (20).

We assessed the worker´s ability to participate in work with the question "what is your current work ability compared to lifetime best?". This first item of widely used Work Ability Index (21) is named Work Ability Score (WAS) and has a 0–10 response scale, where 0 represents "completely unable to work" and 10 "work ability at its best". Reference values for WAS are suggested as for Work Ability Index; poor (0–5 points), moderate (6-7), good (8-9), excellent (10) (22).

Occupational status, working hours per week and the role of shift work in current work were asked with self-administrated questionnaires. Financial situation was assessed with the question "I have to spare expenditures" (yes or no).

Ideal cardiovascular health metrics

Smoking status was assessed by a questionnaire. Nonsmoking was defined as having never smoked or having quit smoking >12 months ago.

Height and weight were measured by a study nurse with subjects in standing position without shoes and outer garments. Weight was measured to the nearest 0,1kg with calibrated scales and height to the nearest 0,5cm with a wall-mounted stadiometer. Body mass index (BMI) was calculated as weight (kg) divided by the square of height (m²). Ideal BMI was <25.0 kg/m^2.

Physical activity was assessed using a questionnaire that asked the frequency and duration of leisure-time physical activity and commuting activities in a typical week. Ideal physical activity was defined as engaging in ≥150 minutes per week of moderate intensity activities or ≥75 minutes per week of vigorous intensity activities or ≥150 minutes per week of moderate + vigorous intensity activities (8).

Information of diet was collected with a food-frequency questionnaire. Daily consumption of fruits,

vegetables, whole grains, unsaturated dietary fats and white meat (poultry, fish) at least three times a week were considered as healthy diet. Intake of the ideal level of each dietary component was scored with one point, for a range of 0–5. The dietary CVH metric was categorized as ideal, if a dietary score of 4–5 was achieved (8).

Blood pressure was measured by a study nurse with an automatic validated blood pressure monitor with subjects in a sitting posture, after resting at least 5 minutes. Two readings taken at intervals of at least 2 minutes were measured, and the mean of these readings was used in the analysis. Ideal level was untreated blood pressure <120 mmHg systolic and <80 mmHg diastolic.

Laboratory tests were determined in blood samples which were obtained after at least 8 hours of fasting. Total cholesterol was measured enzymatically (Architect c4000/c8000). Ideal level was untreated total cholesterol <5.18 mmol/l. Glucose tolerance was measured with glycated hemoglobin (HbA1c) which was analyzed using High Performance Liquid Cromatography - method, HPLC, (Tosoh HLC-723G7 (G7)). The AHA metric uses fasting plasma glucose (<5.55 mmol/l) to determine normoglycemia, however we used HbA1c because its property of giving an indication of glycemia over several preceding weeks rather than at a single time point (23). Normoglycemia was defined as HbA1c <6.0% (<42 mmol/mol) (24).

The seven ideal CVH metrics were grouped to three categories: unfavorable (0-2 ideal CVH metrics), intermediate (3-4) and favorable (5-7) level of cardiovascular health (25).

Psychosocial risk factors

At the clinic, the study nurse assessed psychosocial risk factors by core questions suggested by the European 2012 guidelines on CVD prevention in clinical practice (9):

- Work and family stress: Do you have enough control over how to meet the demands at work? Is your reward appropriate for your effort? Do you have serious problems with your spouse?

- Social isolation: Are you living alone? Do you lack a close confidant?
- Depression: Do you feel down, depressed and hopeless? Have you lost interest and pleasure in life?
- Anxiety: Do you frequently feel nervous, anxious, or on edge? Are you frequently unable to stop or control worrying?
- Hostility: Do you frequently feel angry over little things? Do you often feel annoyed about habits other people have?
- Type D personality: In general, do you often feel anxious, irritable, or depressed? Do you avoid sharing your thoughts and feelings with other people?

Low job demand-control, low effort-reward imbalance and/or ´yes´ answer for one or more items was indicated as a likely psychosocial risk factor.

Other measures

With self-administrated questionnaires and medical records, information was gathered about diseases diagnosed by a physician, years of education, marital status (cohabiting or not) and quality of sleep (good or not good). Alcohol consumption was assessed with the 3-item Alcohol Use Disorders Identification Test (AUDIT-C) with a cutoff of 5 for harmful drinking (26).

Informed consent

The study protocol and consent forms were reviewed and approved by the Ethics Committee of the Hospital District of Southwest Finland. All participants signed a written informed consent for the project and subsequent medical research.

Statistical analysis

Statistical significances for the unadjusted hypothesis of linearity across categories of total work engagement and CVH metrics were evaluated by using the Cochran-Armitage test for trend and

analysis of variance with an appropriate contrast. Adjusted hypothesis of linearity (orthogonal polynomial) were evaluated using generalized linear models (e.g. analysis of co-variance and logistic models) with appropriate distribution and link function. Models included age and education years as covariates. In the case of violation of the assumptions (e.g. non-normality), a bootstrap-type method was used (10 000 replications) to estimate of standard error. The normality of variables was evaluated by the Shapiro-Wilk W test. All analyses were performed using STATA 14.1.

The STROBE Guidelines were followed in this paper.

Results

We evaluated 726 female employees (mean age 48 ± 10 years). Table 1 shows a general overview of the characteristics of the study subjects.

Of the employees, 25.2% had 5-7 CVH metrics, 53.0% had 3-4 metrics, and 21.8% had 0-2 metrics at ideal level. The sum of ideal CVH metrics associated linearly with work engagement driven by the positive relationship of healthy diet and physical activity with work engagement. Financial situation, good quality of sleep and WAS associated positively with work engagement (Table 2).

At least one psychosocial risk factor was reported by 63.3% of the female employees. The prevalence of psychosocial risk factors was as follows: depressive symptoms 18.9%, anxiety 31.4%, hostility 20.9%, type D personality 26.3%, social isolation 17.5%, and stress 31.0%. The prevalence of any psychosocial risk factor decreased linearly with work engagement (Table 2).

Figure 1 shows that in subjects without psychosocial risk factors, total work engagement was high and stable (p-value for linearity 0.14) across the range of the sum of ideal CVH metrics. The presence of even one psychosocial risk factor had negative relationship with work engagement. Linearity between the presence of at least one psychosocial risk factor and work engagement was significant ($p < 0.001$) across the categories of the sum of ideal CVH metrics. The interaction between the presence of psychosocial risk factors and sum of ideal CVH metrics was not significant ($p = 0.79$).

Discussion

According to our study, physical health associates positively with work well-being driven by the positive relationship of healthy diet and physical activity with work engagement. However, even one of the measured psychosocial risk factors negatively associated with the level of work engagement regardless of the sum of ideal CVH metrics.

Our finding that psychosocial risk factors have negative relationship with work engagement is in line with previous studies reporting that employees with a high level of work engagement have lower scores on stress, anxiety and depression (12, 14-17, 27). Especially vigor, characterized by ”energy, mental resilience, the willingness to invest one’s effort and persistence” (10) was linked to decreased depression and anxiety in a 2-year follow-up study (18). Due to technological developments, the nature of work in developed countries has become less physical but more demanding mentally and emotionally, as work pace and stress have increased (28). These changes in daily working life may contribute to adverse health effects, including mental health problems and body weight gain (28). However, work can also contribute in a positive way to mental health providing psychological development, social contacts, a purpose in life and increase in self-esteem and quality of life (28) as seen in a study where work engagement increased life satisfaction (17).

Compared to Finnish reference values (20) work engagement in our subjects was high and stable. Every fourth of our study subjects had 5-7 ideal CVH metrics, which is comparable to US (29). Willis et al. have estimated that individuals in midlife with 5–7 ideal CVH metrics exhibited 25% lower median annual non-CVD costs and 75% lower median CVD costs at old age than those with 0–2 ideal CVH metrics (25). Leijten et al. have shown that work engagement is related to better physical health (30), which is in line with our finding of positive relationship between the sum of ideal CVH metrics and work engagement. However, it is unclear which lifestyle-related efforts could increase work engagement. Enhancing physical activity and fruit intake did not improve work

engagement in a work place health promotion program (31), even though these were the ideal CVH metrics associated with work engagement in the present study. Our finding of an association with quality of sleep and work engagement is established also by Hallberg et al. (15), who showed that poor sleep hygiene decreases work engagement, highlighting that work engagement has a strong health component. Even though physical health is scarcely studied with work engagement, psychological studies have shown many potential factors that increase work engagement, like social support, innovativeness, appreciation (32) and job control (33).

In our study subjects, WAS associated with higher work engagement (7.2 vs 8.8). This supports previous studies showing that work engagement has a positive influence on work ability (34-36). For example, Airila et al. (2014) showed that baseline work ability predicted work ability after a 10-year follow-up directly and indirectly via work engagement. They also studied that increases in job resources (supervisory relations, interpersonal relations, task resources) and self-esteem were related to an increase in work engagement and work ability. Work ability is the degree to which a worker, given his/her health, is physically and mentally able to cope with the demands at work (37). Work engagement is more dependent on mental aspects, whereas work ability comprises also physical condition. Our result still has to be interpreted with caution, because the relationship can also be bidirectional.

For organizational level occupational health care should actively seek psychosocial risk factors, but also focus to enhancing healthy lifestyle, i.e. factors proven to have positive relationship with work engagement. To increase work engagement in individual level it seems that the simplest rule is to eat healthy, exercise in moderate-to-vigorous level, focus on social life and embrace positive attitude. Future studies should focus on individual physical health metrics (e.g. physical activity, blood pressure) evaluated as metric variables, since in this study the ideal CVH metrics are dichotomous variables with strict goals and this can potentially explain the lack of associations with other than diet and physical activity with work engagement. Furthermore, there is a need for

longitudinal studies to explore relationships between physical and mental cardio-protective factors with work engagement.

We acknowledge some limitations of the study. The causality of work engagement with psychosocial risk factors or lifestyle factors cannot be determined due to the cross-sectional nature of our study. A common source bias might explain the relationship with work engagement and mental health, because the construct of work engagement resembles more mental health than the construct of physical health. Diet and physical activity were measured by self-assessment, which may be influenced by social desirability. A possible ”healthy worker effect” (38) can emerge, when subjects out of workforce were not studied. This may cause bias in the generalizability of the results. Also, the exact participation rate for the study is impossible to say, because we cannot know how many of the employees really got or read the invitation e-mail. To screen for psychosocial risk factors, we used simple core questions (9). Answering ´yes´ to one of these questions does not imply that the person actually has a risk factor; e.g. not all people living alone are socially isolated. However, giving an affirmative answer to either one of the two core questions on depression used in the present study, has been shown to be as effective as using a longer screening instruments (39). Also the single-item question, WAS, is proved to have a strong association with the Work Ability Index and to be trustworthy in evaluating work ability (40). Strengths of the study are that we could take into account several aspects of life in many occupational groups. Anthropologic measures were conducted by trained medical staff, and laboratory tests were performed up-to-date.

Conclusions

Our results suggest that both physical and mental cardio-protective factors have positive relationship with work engagement. However, presence of even one psychosocial risk factor has potential to negatively associate with work engagement regardless of the sum of ideal CVH metrics. Longitudinal studies are needed to confirm the direction of these associations.

Declaration of conflicting interests:

The authors declare that there are no conflicts of interest.

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Author contributions:

VV, HK and PK contributed to the conception or design of the work, and to the acquisition, analysis, or interpretation of data for the work. VV and PK drafted the manuscript. All authors critically revised the manuscript and gave final approval and agree to be accountable for all aspects of work ensuring integrity and accuracy.

Data sharing statement:

There is no additional unpublished data from this study. The data can be accessed by Prof. Päivi Korhonen (paikor@utu.fi).

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Table 1. A general overview of the characteristics of the study subjects

Variables	
Age, mean (SD)	48.0 (9.9)
Education years, mean (SD)	13.9 (2.7)
AUDIT-C, mean (SD)	2.9 (1.7)
Height (cm), mean (SD)	165.1 (5.9)
Weight (kg), mean (SD)	72.8 (14.1)
Sum of the total 7 ideal CVH metrics, mean (SD)	3.6 (1.3)
Nonsmoking, n (%)	635 (87.5)
Body mass index (kg/ m^2), mean (SD)	26.7 (4.8)
Healthy diet, n (%)	258 (35.5)
Physical activity at goal, n (%)	290 (39.9)
Blood pressure systolic (mmHg), mean (SD)	131.3 (17.0)
Blood pressure diastolic (mmHg), mean (SD)	85.7 (10.5)
Total cholesterol (mmol/l), mean (SD)	5.3 (0.9)
HbA1c (mmol/mol), mean (SD)	5.5 (0.5)
Sum of the total 6 psychosocial risk factors, mean (SD)	1.5 (1.5)
Work ability score, (NRS), mean (SD)	8.2 (8.2)
Work engagement, mean (SD)	
Total	4.8 (0.9)
Vigor	4.8 (1.0)
Dedication	4.9 (1.0)
Absorption	4.7 (1.1)

Abbreviations: SD; standard deviation, AUDIT-C; Alcohol Use Disorders Identification Test, CVH; cardiovascular health, HbA1c; glycated hemoglobin, NRS; numeric rating scale

Table 2. Characteristics of the study subjects according to the sum of work engagement

Variables	Total work engagement				P-value*	
	Low (≤3.43) n=59	Moderate (3.44-4.53) n=151	High (4.54-5.30) n=276	Very high (>5.30) n=240	Crude	Adjusted**
Age, mean (SD)	47 (11)	48 (9)	47 (10)	49 (9)	0.53	..
Education years, mean (SD)	14.0 (2.5)	14.0 (2.6)	14.0 (2.7)	13.7 (2.8)	0.28	..
Financial situation, n (%)	27 (46)	85 (56)	175 (63)	167 (70)	<0.001	<0.001
Marital status, cohabiting, n (%)	43 (73)	111 (74)	231 (84)	180 (75)	0.59	0.55
Good quality of sleep, n (%)	36 (61)	103 (68)	196 (71)	181 (75)	0.019	0.016
AUDIT-C, mean (SD)	2.9 (2.0)	2.9 (1.7)	3.1 (1.6)	2.7 (1.8)	0.55	0.59
Working hours, hours/week, mean (SD)	41.1 (4.0)	41.2 (3.6)	41.4 (3.9)	41.9 (4.2)	0.12	0.16
Shift work, n (%)	20 (34)	55 (36)	85 (31)	71 (30)	0.20	0.12
WAS, (NRS), mean (SD)	7.2 (1.7)	7.6 (1.4)	8.2 (1.0)	8.8 (0.9)	<0.001	<0.001
Sum of ideal cardiovascular health metrics, n (%)					0.076	0.023
Unfavorable (0-2)	11 (19)	39 (26)	59 (21)	49 (20)		
Intermediate (3-4)	37 (63)	80 (53)	148 (54)	120 (50)		

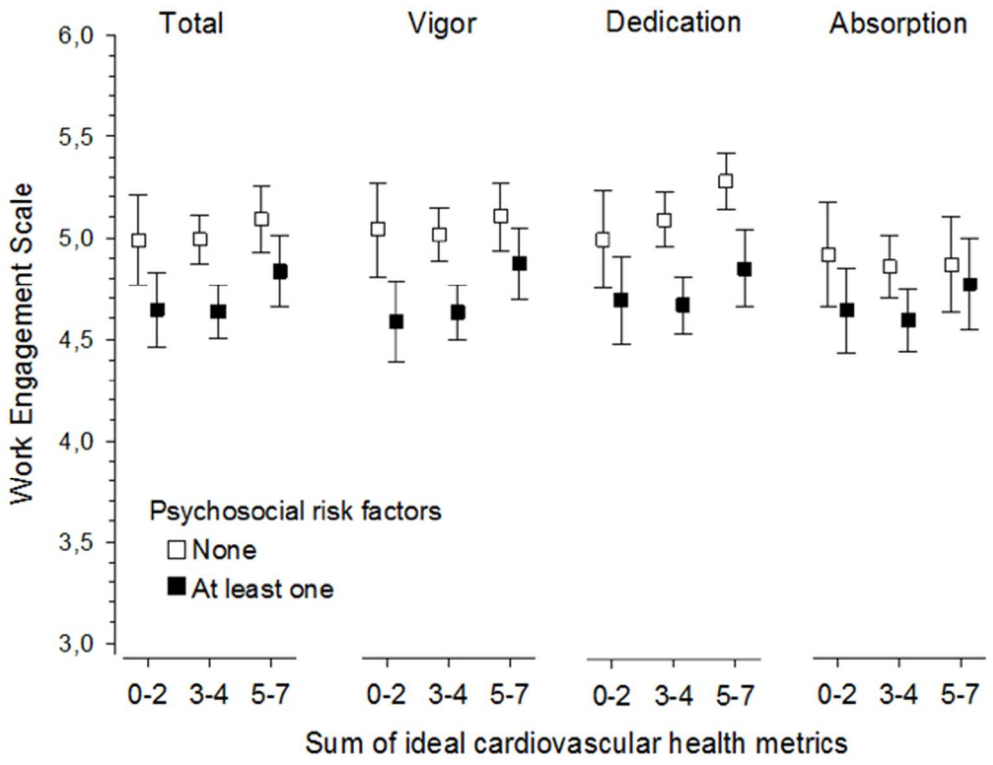
Favorable (5-7)	11 (19)	32 (21)	69 (25)	71 (30)		
Ideal cardiovascular health metrics, n (%)						
Nonsmoking	48 (82)	142 (94)	237 (86)	208 (87)	0.58	0.34
Body mass index <25.0 kg/m^2	30 (51)	63 (42)	117 (42)	87 (36)	0.050	0.070
Physical activity at goal	21 (36)	48 (32)	110 (40)	111 (46)	0.008	0.006
Healthy diet	16 (27)	45 (30)	90 (33)	107 (45)	<0.001	0.001
Untreated blood pressure <120/80mmHg	12 (20)	23 (15)	52 (19)	50 (21)	0.39	0.22
Untreated total cholesterol <5.18mmol/l	26 (44)	61 (40)	121 (44)	111 (46)	0.39	0.23
Untreated HbA1c <6.0% (42 mmol/mol)	54 (92)	139 (92)	263 (95)	215 (90)	0.43	0.58
Any psychosocial risk factor, n (%)	50 (85)	107 (71)	169 (61)	134 (56)	<0.001	<0.001
Depressive symptoms	25 (42)	38 (25)	46 (17)	28 (12)	<0.001	<0.001
Anxiety	31 (53)	57 (38)	83 (30)	57 (24)	<0.001	<0.001
Hostility	23 (39)	34 (23)	57 (21)	38 (16)	<0.001	<0.001
Type D personality	30 (51)	48 (32)	67 (24)	46 (19)	<0.001	<0.001
Social isolation	15 (25)	35 (23)	36 (13)	41 (17)	0.047	0.049
Stress	32 (54)	56 (37)	85 (31)	52 (22)	<0.001	<0.001

* P for linearity

* Adjusted for age and education years

Abbreviations: AUDIT-C; Alcohol Use Disorders Identification Test, WAS; work ability score, NRS; numeric rating scale, HbA1c; glycated hemoglobin

Figure 1. Mean values of total work engagement and its subscales (adjusted for age and education years) according to the sum of ideal cardiovascular health metrics and the prevalence of psychosocial risk factors among the female employees. Whiskers show 95% confidence intervals.



Mean values of total work engagement and its subscales (adjusted for age and education years) according to the sum of ideal cardiovascular health metrics and the prevalence of psychosocial risk factors among the female employees. Whiskers show 95% confidence intervals.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract, see page 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found, see page 2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported see page 4
Objectives	3	State specific objectives, including any prespecified hypotheses see page 5
Methods		
Study design	4	Present key elements of study design early in the paper see pages 1,2,6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection see pages 2, 6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants see page 6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable see pages 6-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group see pages 6-9
Bias	9	Describe any efforts to address potential sources of bias see page 10
Study size	10	Explain how the study size was arrived at see page 6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding, see page 10
		(*b*) Describe any methods used to examine subgroups and interactions see page 10
		(*c*) Explain how missing data were addressed see page 6
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses see page 10

Continued on next page

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed, see page 11
		(b) Give reasons for non-participation at each stage --
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders, see page 22-24 (table 1)
		(b) Indicate number of participants with missing data for each variable of interest --
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures see page 22 (table 1)
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included, see page 22 (table 1)
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses see page 11 results
Discussion		
Key results	18	Summarise key results with reference to study objectives see page 12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias see page 14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence see page 14
Generalisability	21	Discuss the generalisability (external validity) of the study results see page 14
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based, see page 16

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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PHYSICAL AND MENTAL HEALTH FACTORS ASSOCIATED WITH WORK ENGAGEMENT AMONG FINNISH FEMALE MUNICIPAL EMPLOYEES: A CROSS-SECTIONAL STUDY

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PHYSICAL AND MENTAL HEALTH FACTORS ASSOCIATED WITH WORK ENGAGEMENT AMONG FINNISH FEMALE MUNICIPAL EMPLOYEES: A CROSS-SECTIONAL STUDY

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ABSTRACT

OBJECTIVES: Work engagement is related to mental health, but studies of physical health's association with work engagement are scarce. This study aims to evaluate the relationship between physical health, psychosocial risk factors and work engagement among Finnish women in municipal work units.

METHODS: A cross-sectional study was conducted in 2014 among 726 female employees from ten municipal work units of the city of Pori, Finland. Work engagement was assessed with the 9-item Utrecht Work Engagement Scale. The American Heart Association's concept of ideal cardiovascular health (CVH) was used to define physical health (nonsmoking, body mass index <25.0 kg/m^2, physical activity at goal, healthy diet, total cholesterol <5.18 mmol/l, blood pressure <120/80 mmHg, normal glucose tolerance). Psychosocial risk factors (social isolation, stress, depressive symptoms, anxiety, hostility, and type D personality) were included as core questions suggested by 2012 European Guidelines on cardiovascular disease prevention.

RESULTS: Of the study subjects, 25.2% had favorable 5-7 CVH metrics. The sum of CVH metrics, healthy diet, and physical activity at goal were positively associated with work engagement. In subjects without psychosocial risk factors (36.7%), work engagement was high and stable. Presence of even one psychosocial risk factor was associated with a lower level of work engagement regardless of the sum of ideal CVH metrics.

CONCLUSIONS: Both physical and mental health factors have a positive relationship with work engagement, whereas the presence of even one psychosocial risk factor has a negative association regardless of the level of classic cardiovascular risk factors.

Word count: 245/250

Strenghts and limitations of this study

- Anthropologic measurements were made by trained medical staff and the laboratory tests performed were up-to-date
- Several aspects of life both at work and in leisure time could be taken into account in many of the occupational groups
- Any causality cannot be determined due to the cross-sectional nature of our study
- The exact participation rate for the study is impossible to estimate, because we cannot know how many of the employees actually received or read the invitation e-mail

Keywords: physical health, mental health, ideal cardiovascular health, work engagement, psychosocial risk factors, women

PHYSICAL AND MENTAL HEALTH FACTORS ASSOCIATED WITH WORK ENGAGEMENT AMONG FINNISH FEMALE MUNICIPAL EMPLOYEES: A CROSS-SECTIONAL STUDY

Introduction

Cardiovascular disease (CVD) is a major health burden explaining 50% of all causes of death in the global working population (1), thus leading to a reduction in work ability and premature workforce loss (2). Unfortunately, in women, coronary event rates have not decreased during the last two decades (3-7) and women-focused nuances are needed in the prevention of CVD.

The American Heart Association (AHA) has created a concept of ideal cardiovascular health (CVH), which aims to reduce CVD mortality and improve cardiovascular risk factors in the US population by 20% by 2020 (8). Ideal CVH is defined as the simultaneous presence of favorable health behaviors (nonsmoking, ideal body mass index, physical activity at goal, healthy diet) and health factors at an ideal level (total cholesterol, blood pressure, fasting plasma glucose) (8). Psychosocial factors also have potential to affect the onset or progression of CVD. European Guidelines on CVD prevention in clinical practice emphasize that low socio-economic status, lack of social support, stress at work and in family life, depression, anxiety, hostility, and a type D personality can act as barriers to treatment adherence and efforts to improve lifestyle, as well as deterring the promotion of health and well-being in patients and populations (9).

Although work plays a prominent role in our lives, studies of the health-enhancing potential of work engagement are scarce. Work engagement is a positive psychological construct, which is defined as “a positive, fulfilling, work-related state of mind that is characterized by vigor, dedication and absorption” (10). Work engagement is positively related to perceived health status (11) and negatively with psychological distress, physical complaints (12-14) and depressive

symptoms (15-18).

Identifying factors influencing work engagement and enhancing a healthy lifestyle is a wishful strategy for prevention of CVD. This study aims to assess cardiovascular health, psychosocial factors, and work engagement among female employees in municipal work units. We hypothesize that cardio-protective factors have a positive relationship with work engagement. More specifically, we hypothesized that the individual and the sum of CVH metrics would associate with work engagement. Furthermore, we wanted to examine whether the presence of psychosocial risk factors would affect work engagement evaluated across the categories of CVH metrics.

Materials and Methods

Participants and study design

PORTAAT (PORi To Aid Against Threats) is a longitudinal study conducted among employees of the city of Pori (83 497 inhabitants in 2014) in South-Western Finland. The study population comprised workers from ten work units, which were selected by the chief of the municipal welfare unit of Pori. The main selection criterion was that the work unit had not been involved in any other health promoting program than routine occupational health care during the past 10 years. An invitation and study information letters were sent to the employees as an email attachment by the managers of the work units. Information events were also organized for employees. There were no exclusion criteria. Altogether 836 employees (104 males, 732 females) consented to participate in the PORTAAT study. For this cross-sectional paper, we analyzed the data of 726 female employees working in libraries (n=22), museums (n=33), technical management (n=80), social services (=195), and health care units (n=396), who had completed the work engagement questionnaire.

Measures

Work-related measures

Work engagement was measured with the 9-item Utrecht Work Engagement Scale (UWES-9) (19). UWES-9 consists of three subscales; vigor, dedication, and absorption, which were scored on a 7-point Likert scale ranging from 0 (never) to 6 (daily). The mean subscale score was computed by adding the scores on the particular scale and dividing the sum by the number of items in the subscale involved. A similar procedure was followed for the total score. The higher each item was rated the higher the overall work engagement. The Finnish values for total work engagement are <1.44 (very low), 1.44-3.43 (low), 3.44-4.53 (moderate), 4.54-5.30 (high) and 5.31-6.00 (very high) (20).

We assessed the worker´s ability to participate in work with the question "what is your current work ability compared to your lifetime best?". This first item of the widely used Work Ability Index (21) is named Work Ability Score (WAS) and has a 0–10 response scale, where 0 represents "completely unable to work" and 10 "work ability at its best". Similar reference values for WAS were used for the Work Ability Index; poor (0–5 points), moderate (6-7), good (8-9), excellent (10) (22).

Questions were asked as regards occupational status, working hours per week, and the role of shift work in current work using self-administrated questionnaires. The participants financial situation was assessed with the question "I have to spare expenditures" (yes or no).

Ideal cardiovascular health metrics

Smoking status was assessed by the questionnaire. Nonsmoking was defined as having never smoked or having quit smoking >12 months ago.

Height and weight were measured by a study nurse with the subjects in a standing position without shoes and outer garments. Weight was measured to the nearest 0,1kg with calibrated scales and height to the nearest 0,5cm with a wall-mounted stadiometer. Body mass index (BMI) was calculated as weight (kg) divided by the square of height (m²). The Ideal BMI was <25.0 kg/m^2.

Physical activity was assessed using a questionnaire that asked the frequency and duration of leisure-time physical activity and commuting activities in a typical week. Ideal physical activity was defined as engaging in ≥150 minutes per week of moderately intense activities or ≥75 minutes per week of vigorously intense activities or ≥150 minutes per week of moderately + vigorously intense activities (8).

Information concerning diet was collected with a food-frequency questionnaire. Daily consumption

of fruits, vegetables, whole grains, unsaturated dietary fats and white meat (poultry, fish) at least three times a week were considered to be a healthy diet. Intake of the ideal level of each dietary component was scored with one point, from a range of 0–5. The dietary CVH metric was categorized as ideal, if a dietary score of 4–5 was achieved (8).

Blood pressure was measured by a study nurse with an automatic validated blood pressure monitor with subjects in a sitting posture, after resting for at least 5 minutes. Two readings, taken at intervals of at least 2 minutes, were measured, and the mean used in the analysis. The ideal level was an untreated blood pressure of <120 mmHg systolic and <80 mmHg diastolic.

Laboratory tests were determined in blood samples which were obtained after at least 8 hours of fasting. Total cholesterol was measured enzymatically (Architect c4000/c8000). The ideal level was an untreated total cholesterol <5.18 mmol/l. Glucose tolerance was measured with glycated hemoglobin (HbA1c) which was analyzed using High Performance Liquid Cromatography - method, HPLC, (Tosoh HLC-723G7 (G7)). The AHA metric uses fasting plasma glucose (<5.55 mmol/l) to determine normoglycemia, however, we used HbA1c because of its property of giving an indication of glycemia over several preceding weeks rather than at a single time point (23). Normoglycemia was defined as HbA1c <6.0% (<42 mmol/mol) (24).

The seven ideal CVH metrics were grouped into three categories: unfavorable (0-2 ideal CVH metrics), intermediate (3-4) and favorable (5-7) level of cardiovascular health (25).

Psychosocial risk factors

At the clinic, the study nurse assessed the psychosocial risk factors by asking core questions suggested by the European 2012 guidelines on CVD prevention in clinical practice (9):

- Work and family stress: Do you have enough control over how to meet the demands at work? Is your reward appropriate for your effort? Do you have serious problems with your spouse?

- Social isolation: Are you living alone? Do you lack a close confidant?
- Depression: Do you feel down, depressed, and hopeless? Have you lost interest and pleasure in life?
- Anxiety: Do you frequently feel nervous, anxious, or on edge? Are you frequently unable to stop or control worrying?
- Hostility: Do you frequently feel angry over little things? Do you often feel annoyed about the habits other people have?
- Type D personality: In general, do you often feel anxious, irritable, or depressed? Do you avoid sharing your thoughts and feelings with other people?

Low job demand-control, low effort-reward imbalance and/or a ´yes´ answer to one or more items was an indication of a likely psychosocial risk factor.

Other measures

With self-administrated questionnaires and medical records, information was gathered about diseases diagnosed by a physician, years of education, marital status (cohabiting or not) and quality of sleep (good or not good). Alcohol consumption was assessed with the 3-item Alcohol Use Disorders Identification Test (AUDIT-C) with a cutoff of 5 for harmful drinking (26).

Informed consent

The study protocol and consent forms were reviewed and approved by the Ethics Committee of the Hospital District of Southwest Finland. All participants signed a written informed consent for the project and subsequent medical research.

Statistical analysis

Statistical significances for the unadjusted hypothesis of linearity across categories of total work engagement and CVH metrics were evaluated by using the Cochran-Armitage test for trend and

analysis of variance with an appropriate contrast. Adjusted hypothesis of linearity (orthogonal polynomial) were evaluated using generalized linear models (e.g. analysis of co-variance and logistic models) with appropriate distribution and link function. Models included age and education years as covariates. In the case of violation of the assumptions (e.g. non-normality), a bootstrap-type method was used (10 000 replications) to estimate the standard error. A backward-stepwise linear regression model (probability for entry 0.05; probability for removal 0.10) was used to identify explanatory variables for continuous work engagement using the standardized regression coefficient Beta (β). The Beta value is a measure of how strongly each predictor variable influences the criterion (dependent) variable. The Beta is measured in units of standard deviation. Cohen's standard for Beta values above 0.10, 0.30 and 0.50 represent small, moderate and large relationships, respectively. The normality of variables was evaluated by the Shapiro-Wilk W test. All analyses were performed using STATA 14.1.

The STROBE Guidelines were followed in this paper.

Results

We evaluated 726 female employees (mean age 48 ± 10 years). Table 1 shows a general overview of the characteristics of the study subjects.

Table 1. A general overview of the characteristics of the study subjects

Variables	
Age, mean (SD)	48.0 (9.9)
Education years, mean (SD)	13.9 (2.7)
AUDIT-C, mean (SD)	2.9 (1.7)
Height (cm), mean (SD)	165.1 (5.9)
Weight (kg), mean (SD)	72.8 (14.1)
Sum of the total 7 ideal CVH metrics, mean (SD)	3.6 (1.3)
Nonsmoking, n (%)	635 (87.5)
Body mass index (kg/ m^2), mean (SD)	26.7 (4.8)
Healthy diet, n (%)	258 (35.5)
Physical activity at goal, n (%)	290 (39.9)
Blood pressure systolic (mmHg), mean (SD)	131.3 (17.0)
Blood pressure diastolic (mmHg), mean (SD)	85.7 (10.5)
Total cholesterol (mmol/l), mean (SD)	5.3 (0.9)
HbA1c (mmol/mol), mean (SD)	5.5 (0.5)
Sum of the total 6 psychosocial risk factors, mean (SD)	1.5 (1.5)
Work ability score, (NRS), mean (SD)	8.2 (8.2)
Work engagement, mean (SD)	
Total	4.8 (0.9)
Vigor	4.8 (1.0)
Dedication	4.9 (1.0)
Absorption	4.7 (1.1)

Abbreviations: SD; standard deviation, AUDIT-C; Alcohol Use Disorders Identification Test, CVH; cardiovascular health, HbA1c; glycated hemoglobin, NRS; numeric rating scale

Of the employees, 25.2% had 5-7 CVH metrics, 53.0% had 3-4 metrics, and 21.8% had 0-2 metrics at the ideal level. The sum of ideal CVH metrics were associated linearly with work engagement driven by the positive relationship of healthy diet and physical activity with work engagement. Financial situation, good quality of sleep, and WAS were associated positively with work engagement (Table 2).

At least one psychosocial risk factor was reported by 63.3% of the female employees. The prevalence of psychosocial risk factors were as follows: depressive symptoms 18.9%, anxiety 31.4%, hostility 20.9%, type D personality 26.3%, social isolation 17.5%, and stress 31.0%. The prevalence of any psychosocial risk factor decreased linearly with work engagement (Table 2).

Table 2. Characteristics of the study subjects according to the sum of work engagement

Variables	Total work engagement				P-value*	
	Low (≤3.43) n=59	Moderate (3.44-4.53) n=151	High (4.54-5.30) n=276	Very high (>5.30) n=240	Crude	Adjusted**
Age, mean (SD)	47 (11)	48 (9)	47 (10)	49 (9)	0.53	..
Education years, mean (SD)	14.0 (2.5)	14.0 (2.6)	14.0 (2.7)	13.7 (2.8)	0.28	..
Financial situation, n (%)	27 (46)	85 (56)	175 (63)	167 (70)	<0.001	<0.001
Marital status, cohabiting, n (%)	43 (73)	111 (74)	231 (84)	180 (75)	0.59	0.55

Good quality of sleep, n (%)	36 (61)	103 (68)	196 (71)	181 (75)	0.019	0.016
AUDIT-C, mean (SD)	2.9 (2.0)	2.9 (1.7)	3.1 (1.6)	2.7 (1.8)	0.55	0.59
Working hours, hours/week, mean (SD)	41.1 (4.0)	41.2 (3.6)	41.4 (3.9)	41.9 (4.2)	0.12	0.16
Shift work, n (%)	20 (34)	55 (36)	85 (31)	71 (30)	0.20	0.12
WAS, (NRS), mean (SD)	7.2 (1.7)	7.6 (1.4)	8.2 (1.0)	8.8 (0.9)	<0.001	<0.001
Sum of ideal cardiovascular health metrics, n (%)					0.076	0.023
Unfavorable (0-2)	11 (19)	39 (26)	59 (21)	49 (20)		
Intermediate (3-4)	37 (63)	80 (53)	148 (54)	120 (50)		
Favorable (5-7)	11 (19)	32 (21)	69 (25)	71 (30)		
Ideal cardiovascular health metrics, n (%)						
Nonsmoking	48 (82)	142 (94)	237 (86)	208 (87)	0.58	0.34
Body mass index <25.0 kg/m^2	30 (51)	63 (42)	117 (42)	87 (36)	0.050	0.070
Physical activity at goal	21 (36)	48 (32)	110 (40)	111 (46)	0.008	0.006
Healthy diet	16 (27)	45 (30)	90 (33)	107 (45)	<0.001	0.001
Untreated blood pressure <120/80mmHg	12 (20)	23 (15)	52 (19)	50 (21)	0.39	0.22
Untreated total cholesterol <5.18mmol/l	26 (44)	61 (40)	121 (44)	111 (46)	0.39	0.23

Untreated HbA1c <6.0% (42 mmol/mol)	54 (92)	139 (92)	263 (95)	215 (90)	0.43	0.58
Any psychosocial risk factor, n (%)	50 (85)	107 (71)	169 (61)	134 (56)	<0.001	<0.001
Depressive symptoms	25 (42)	38 (25)	46 (17)	28 (12)	<0.001	<0.001
Anxiety	31 (53)	57 (38)	83 (30)	57 (24)	<0.001	<0.001
Hostility	23 (39)	34 (23)	57 (21)	38 (16)	<0.001	<0.001
Type D personality	30 (51)	48 (32)	67 (24)	46 (19)	<0.001	<0.001
Social isolation	15 (25)	35 (23)	36 (13)	41 (17)	0.047	0.049
Stress	32 (54)	56 (37)	85 (31)	52 (22)	<0.001	<0.001

* P for linearity

* Adjusted for age and years of education

Abbreviations: AUDIT-C; Alcohol Use Disorders Identification Test, WAS; work ability score, NRS; numeric rating scale, HbA1c; glycated hemoglobin

Age, BMI, WAS, depressive symptoms, hostility and stress were entered into the backward-stepwise regression model as explanatory variables for continuous work engagement (Figure 1). WAS had a strong positive relationship with work engagement while age had a small one. BMI, depressive symptoms, hostility, and stress had a small negative influence on work engagement.

Figure 2 shows that in subjects without psychosocial risk factors, total work engagement was high and stable (p-value for linearity 0.14) across the range of the sum of ideal CVH metrics. The presence of even one psychosocial risk factor had a negative relationship with work engagement.

Linearity between the presence of at least one psychosocial risk factor and work engagement was significant ($p < 0.001$) across the categories of the sum of ideal CVH metrics. The interaction between the presence of psychosocial risk factors and the sum of ideal CVH metrics was not significant ($p = 0.79$).

Discussion

According to our study, physical health is positively associated with work well-being driven by the positive relationship of a healthy diet and physical activity with work engagement. However, even one of the measured psychosocial risk factors had a negative association with the level of work engagement regardless of the sum of ideal CVH metrics.

Our finding that psychosocial risk factors have a negative relationship with work engagement is in line with previous studies reporting that employees with a high level of work engagement have lower scores on stress, anxiety and depression (12, 14-17, 27). Vigor especially, characterized by energy, mental resilience, the willingness to invest one's effort and persistence (10) was linked to decreased depression and anxiety in a 2-year follow-up study (18). Due to technological developments, the nature of work in developed countries has become less physical but more demanding mentally and emotionally, as work pace and stress have increased (28). These changes in daily working life may contribute to adverse health effects, including mental health problems and body weight gain (28). However, work can also contribute in a positive way to mental health providing psychological development, social contacts, a purpose in life and an increase in self-esteem and quality of life (28) as seen in the study where work engagement increased life satisfaction (17).

Compared to Finnish reference values (20) work engagement in our subjects was high and stable. Every fourth of our study subjects had 5-7 ideal CVH metrics, which is comparable to the US (29). Willis et al. have estimated that individuals in midlife with 5–7 ideal CVH metrics exhibited 25% lower median annual non-CVD costs and 75% lower median CVD costs in old age than those with 0–2 ideal CVH metrics (25). Leijten et al. have shown that work engagement is related to better physical health (30), which is in line with our finding of a positive relationship between the sum of ideal CVH metrics and work engagement. However, it is unclear which lifestyle-related efforts

could increase work engagement. Enhancing physical activity and fruit intake did not improve work engagement in a work place health promotion program (31), even though these were the ideal CVH metrics associated with work engagement in the present study. Our finding of an association with quality of sleep and work engagement has also been established by Hallberg et al. (15), who showed that poor sleep hygiene decreases work engagement, highlighting that work engagement has a strong health component. Even though physical health is rarely studied with work engagement, psychological studies have shown many potential factors that increase work engagement, such as social support, innovativeness, appreciation (32) and job control (33).

In our study subjects, WAS was strongly associated with higher work engagement (7.2 vs 8.8). This supports previous studies showing that work engagement has a positive influence on work ability (34-36). For example, Airila et al. (2014) showed that baseline work ability predicted work ability after a 10-year follow-up directly and indirectly via work engagement. They also demonstrated that better job resources (supervisory relations, interpersonal relations, task resources) and self-esteem were related to increased work engagement and work ability. Work ability is the degree to which a worker, given his/her health, is physically and mentally able to cope with the demands at work (37). Work engagement is more dependent on mental aspects, whereas work ability also involves the subject's physical condition. Our result still has to be interpreted with caution, because the relationship can also be bidirectional.

At an organizational level, occupational health care should actively seek for psychosocial risk factors, but also focus on enhancing a healthy lifestyle, i.e. factors proven to have a positive relationship with work engagement. To increase work engagement at an individual level it seems that the simplest rule is to eat healthy, exercise at a moderate-to-vigorous level, focus on social life and embrace positive attitude. Future studies should focus on individual physical health metrics (e.g. physical activity, blood pressure) evaluated as metric variables, since in this study the ideal CVH metrics are dichotomous variables with strict goals and this can potentially explain the lack of

any associations with work engagement other than those of diet and physical activity. Furthermore, there is a need for longitudinal studies to explore relationships between physical and mental cardio-protective factors with work engagement.

We acknowledge some limitations of the study. The causality of work engagement with psychosocial risk factors or lifestyle factors cannot be determined due to the cross-sectional nature of our study. A common source bias might explain the relationship with work engagement and mental health, because the construct of work engagement resembles more a mental health context than the construct of physical health. Diet and physical activity were measured by self-assessment, which may be influenced by social desirability. A possible healthy worker effect (38) can emerge, as subjects out of the workforce were not studied. This may cause bias in the generalizability of the results. In addition, the exact participation rate for the study is impossible to estimate, because we cannot know how many of the employees actually received or read the invitation e-mail. To screen for psychosocial risk factors, we used simple core questions (9). Answering ´yes´ to one of these questions does not imply that the person actually has a risk factor; e.g. not all people living alone are socially isolated. However, giving an affirmative answer to either one of the two core questions on depression used in the present study, has been shown to be as effective as using longer screening instruments (39). However, the single-item question WAS, has a strong association with the Work Ability Index and is trustworthy in evaluating work ability (40). The strengths of the study are that we could take into account several aspects of life in many occupational groups. Anthropologic measures were conducted by trained medical staff, and the laboratory tests performed were up-to-date.

Conclusions

Our results suggest that both physical and mental cardio-protective factors have a positive relationship with work engagement. However, the presence of even one psychosocial risk factor has potential to associate negatively with work engagement regardless of the sum of ideal CVH metrics. Longitudinal studies are needed to confirm the direction of these associations.

Declaration of conflicting interests:

The authors declare that there are no conflicts of interest.

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Author contributions:

VV, HK and PK contributed to the conception or design of the work, and to the acquisition, analysis, or interpretation of data for the work. VV and PK drafted the manuscript. All authors critically revised the manuscript and gave final approval and agree to be accountable for all aspects of work ensuring integrity and accuracy.

Data sharing statement:

There is no additional unpublished data from this study. The data can be accessed by Prof. Päivi Korhonen (paikor@utu.fi).

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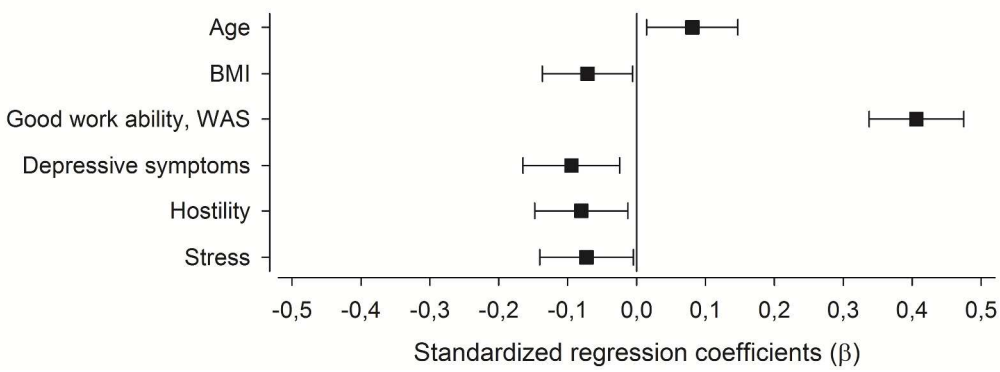
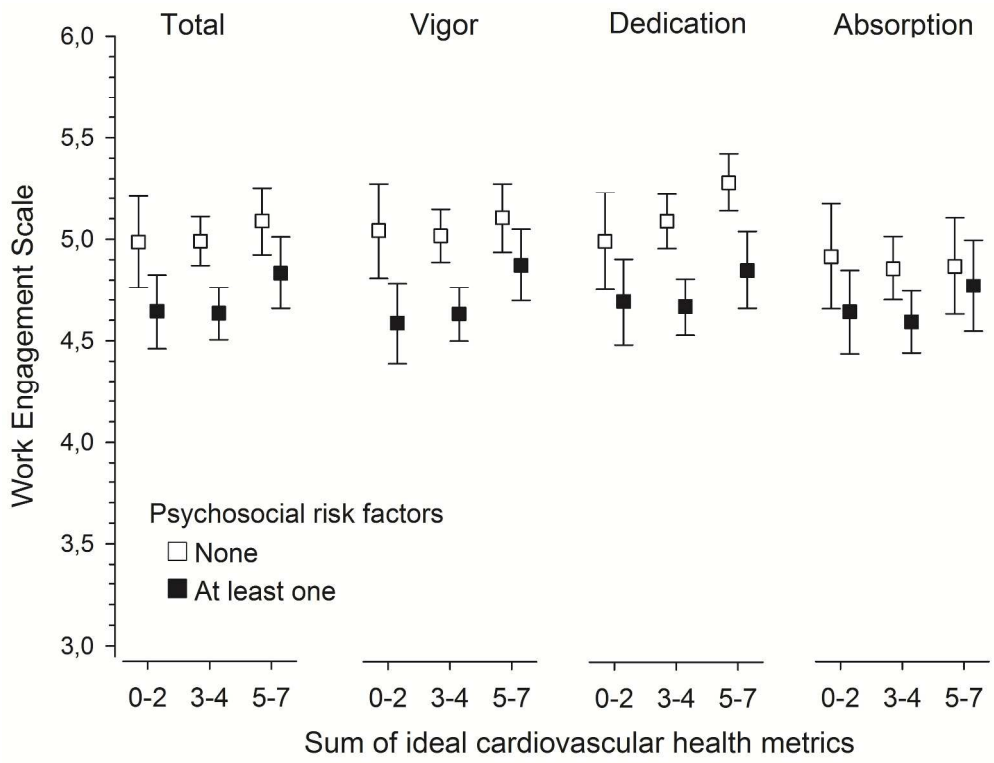
Figure 1. Backward-stepwise regression model as an explanatory variable for continuous work engagement (β-values with 95% confidence intervals). All variables presented in Table 2 included explanatory variable. Only those variables shown which entered the model.

Figure 2. Mean with 95% confidence intervals of total work engagement and its subscales (adjusted for age and years of education) according to the sum of ideal cardiovascular health metrics and the prevalence of psychosocial risk factors among the female employees.



Backward-stepwise regression model as an explanatory variable for continuous work engagement (β-values with 95% confidence intervals). All variables presented in Table 2 included explanatory variable. Only those variables shown which entered the model.



Mean with 95% confidence intervals of total work engagement and its subscales (adjusted for age and years of education) according to the sum of ideal cardiovascular health metrics and the prevalence of psychosocial risk factors among the female employees.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract, see page 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found, see page 2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported see page 4
Objectives	3	State specific objectives, including any prespecified hypotheses see page 5
Methods		
Study design	4	Present key elements of study design early in the paper see pages 1,2,6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection see pages 2, 6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants see page 6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable see pages 6-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group see pages 6-9
Bias	9	Describe any efforts to address potential sources of bias see page 10
Study size	10	Explain how the study size was arrived at see page 6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding, see page 10
		(*b*) Describe any methods used to examine subgroups and interactions see page 10
		(*c*) Explain how missing data were addressed see page 6
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses see page 10

Continued on next page

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed, see page 11
		(b) Give reasons for non-participation at each stage --
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders, see page 22-24 (table 1)
		(b) Indicate number of participants with missing data for each variable of interest --
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures see page 22 (table 1)
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included, see page 22 (table 1)
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses see page 11 results
Discussion		
Key results	18	Summarise key results with reference to study objectives see page 12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias see page 14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence see page 14
Generalisability	21	Discuss the generalisability (external validity) of the study results see page 14
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based, see page 16

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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PHYSICAL AND MENTAL HEALTH FACTORS ASSOCIATED WITH WORK ENGAGEMENT AMONG FINNISH FEMALE MUNICIPAL EMPLOYEES: A CROSS-SECTIONAL STUDY

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Keywords:	ideal cardiovascular health, physical health, psychosocial risk factors, work engagement, work well-being

PHYSICAL AND MENTAL HEALTH FACTORS ASSOCIATED WITH WORK ENGAGEMENT AMONG FINNISH FEMALE MUNICIPAL EMPLOYEES: A CROSS-SECTIONAL STUDY

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ABSTRACT

OBJECTIVES: Work engagement is related to mental health, but studies of physical health's association with work engagement are scarce. This study aims to evaluate the relationship between physical health, psychosocial risk factors and work engagement among Finnish women in municipal work units.

METHODS: A cross-sectional study was conducted in 2014 among 726 female employees from ten municipal work units of the city of Pori, Finland. Work engagement was assessed with the 9-item Utrecht Work Engagement Scale. The American Heart Association's concept of ideal cardiovascular health (CVH) was used to define physical health (nonsmoking, body mass index <25.0 kg/m^2, physical activity at goal, healthy diet, total cholesterol <5.18 mmol/l, blood pressure <120/80 mmHg, normal glucose tolerance). Psychosocial risk factors (social isolation, stress, depressive symptoms, anxiety, hostility, and type D personality) were included as core questions suggested by 2012 European Guidelines on cardiovascular disease prevention.

RESULTS: Of the study subjects, 25.2% had favorable 5-7 CVH metrics. The sum of CVH metrics, healthy diet, and physical activity at goal were positively associated with work engagement. In subjects without psychosocial risk factors (36.7%), work engagement was high and stable. Presence of even one psychosocial risk factor was associated with a lower level of work engagement regardless of the sum of ideal CVH metrics.

CONCLUSIONS: Both physical and mental health factors have a positive relationship with work engagement, whereas the presence of even one psychosocial risk factor has a negative association regardless of the level of classic cardiovascular risk factors.

Word count: 245/250

Strenghts and limitations of this study

- Anthropologic measurements were made by trained medical staff and the laboratory tests performed were up-to-date
- Several aspects of life both at work and in leisure time could be taken into account in many of the occupational groups
- Any causality cannot be determined due to the cross-sectional nature of our study
- The exact participation rate for the study is impossible to estimate, because we cannot know how many of the employees actually received or read the invitation e-mail

Keywords: physical health, mental health, ideal cardiovascular health, work engagement, psychosocial risk factors, women

PHYSICAL AND MENTAL HEALTH FACTORS ASSOCIATED WITH WORK ENGAGEMENT AMONG FINNISH FEMALE MUNICIPAL EMPLOYEES: A CROSS-SECTIONAL STUDY

Introduction

Cardiovascular disease (CVD) is a major health burden explaining 50% of all causes of death in the global working population (1), thus leading to a reduction in work ability and premature workforce loss (2). Unfortunately, in women, coronary event rates have not decreased during the last two decades (3-7) and women-focused nuances are needed in the prevention of CVD.

The American Heart Association (AHA) has created a concept of ideal cardiovascular health (CVH), which aims to reduce CVD mortality and improve cardiovascular risk factors in the US population by 20% by 2020 (8). Ideal CVH is defined as the simultaneous presence of favorable health behaviors (nonsmoking, ideal body mass index, physical activity at goal, healthy diet) and health factors at an ideal level (total cholesterol, blood pressure, fasting plasma glucose) (8). Psychosocial factors also have potential to affect the onset or progression of CVD. European Guidelines on CVD prevention in clinical practice emphasize that low socio-economic status, lack of social support, stress at work and in family life, depression, anxiety, hostility, and a type D personality can act as barriers to treatment adherence and efforts to improve lifestyle, as well as deterring the promotion of health and well-being in patients and populations (9).

Although work plays a prominent role in our lives, studies of the health-enhancing potential of work engagement are scarce. Work engagement is a positive psychological construct, which is defined as “a positive, fulfilling, work-related state of mind that is characterized by vigor, dedication and absorption” (10). Work engagement is positively related to perceived health status (11) and negatively with psychological distress, physical complaints (12-14) and depressive

symptoms (15-18).

Identifying factors influencing work engagement and enhancing a healthy lifestyle is a wishful strategy for prevention of CVD. This study aims to assess cardiovascular health, psychosocial factors, and work engagement among female employees in municipal work units. We hypothesize that cardio-protective factors have a positive relationship with work engagement. More specifically, we hypothesized that the individual and the sum of CVH metrics would associate with work engagement. Furthermore, we wanted to examine whether the presence of psychosocial risk factors would affect work engagement evaluated across the categories of CVH metrics.

Materials and Methods

Participants and study design

PORTAAT (PORi To Aid Against Threats) is a longitudinal study conducted among employees of the city of Pori (83 497 inhabitants in 2014) in South-Western Finland. The study population comprised workers from ten work units, which were selected by the chief of the municipal welfare unit of Pori. The main selection criterion was that the work unit had not been involved in any other health promoting program than routine occupational health care during the past 10 years. An invitation and study information letters were sent to the employees as an email attachment by the managers of the work units. Information events were also organized for employees. There were no exclusion criteria. Altogether 836 employees (104 males, 732 females) consented to participate in the PORTAAT study. For this cross-sectional paper, we analyzed the data of 726 female employees working in libraries (n=22), museums (n=33), technical management (n=80), social services (=195), and health care units (n=396), who had completed the work engagement questionnaire.

Measures

Work-related measures

Work engagement was measured with the 9-item Utrecht Work Engagement Scale (UWES-9) (19). UWES-9 consists of three subscales; vigor, dedication, and absorption, which were scored on a 7-point Likert scale ranging from 0 (never) to 6 (daily). The mean subscale score was computed by adding the scores on the particular scale and dividing the sum by the number of items in the subscale involved. A similar procedure was followed for the total score. The higher each item was rated the higher the overall work engagement. The Finnish values for total work engagement are <1.44 (very low), 1.44-3.43 (low), 3.44-4.53 (moderate), 4.54-5.30 (high) and 5.31-6.00 (very high) (20).

We assessed the worker´s ability to participate in work with the question "what is your current work ability compared to your lifetime best?". This first item of the widely used Work Ability Index (21) is named Work Ability Score (WAS) and has a 0–10 response scale, where 0 represents "completely unable to work" and 10 "work ability at its best". Similar reference values for WAS were used for the Work Ability Index; poor (0–5 points), moderate (6-7), good (8-9), excellent (10) (22).

Questions were asked as regards occupational status, working hours per week, and the role of shift work in current work using a self-administrated questionnaires. The participants financial situation was assessed with the question "I have to spare expenditures" (yes or no).

Ideal cardiovascular health metrics

Smoking status was assessed by the questionnaire. Nonsmoking was defined as having never smoked or having quit smoking >12 months ago.

Height and weight were measured by a study nurse with the subjects in a standing position without shoes and outer garments. Weight was measured to the nearest 0,1kg with calibrated scales and height to the nearest 0,5cm with a wall-mounted stadiometer. Body mass index (BMI) was calculated as weight (kg) divided by the square of height (m^2). The ideal BMI was <25.0 kg/m^2.

Physical activity was assessed using a questionnaire that asked the frequency and duration of leisure-time physical activity and commuting activities in a typical week. Ideal physical activity was defined as engaging in ≥150 minutes per week of moderately intense activities or ≥75 minutes per week of vigorously intense activities or ≥150 minutes per week of moderately + vigorously intense activities (8).

Information concerning diet was collected with a food-frequency questionnaire. Daily consumption

of fruits, vegetables, whole grains, unsaturated dietary fats and white meat (poultry, fish) at least three times a week were considered to be a healthy diet. Intake of the ideal level of each dietary component was scored with one point, from a range of 0–5. The dietary CVH metric was categorized as ideal, if a dietary score of 4–5 was achieved (8).

Blood pressure was measured by a study nurse with an automatic validated blood pressure monitor with subjects in a sitting posture, after resting for at least 5 minutes. Two readings, taken at intervals of at least 2 minutes, were measured, and the mean used in the analysis. The ideal level was an untreated blood pressure of <120 mmHg systolic and <80 mmHg diastolic.

Laboratory tests were determined in blood samples which were obtained after at least 8 hours of fasting. Total cholesterol was measured enzymatically (Architect c4000/c8000). The ideal level was an untreated total cholesterol <5.18 mmol/l. Glucose tolerance was measured with glycated hemoglobin (HbA1c) which was analyzed using High Performance Liquid Cromatography - method, HPLC, (Tosoh HLC-723G7 (G7)). The AHA metric uses fasting plasma glucose (<5.55 mmol/l) to determine normoglycemia, however, we used HbA1c because of its property of giving an indication of glycemia over several preceding weeks rather than at a single time point (23). Normoglycemia was defined as HbA1c <6.0% (<42 mmol/mol) (24).

The seven ideal CVH metrics were grouped into three categories: unfavorable (0-2 ideal CVH metrics), intermediate (3-4) and favorable (5-7) level of cardiovascular health (25).

Psychosocial risk factors

At the clinic, the study nurse assessed the psychosocial risk factors by asking core questions suggested by the European 2012 guidelines on CVD prevention in clinical practice (9):

- Work and family stress: Do you have enough control over how to meet the demands at work? Is your reward appropriate for your effort? Do you have serious problems with your spouse?

- Social isolation: Are you living alone? Do you lack a close confidant?
- Depression: Do you feel down, depressed, and hopeless? Have you lost interest and pleasure in life?
- Anxiety: Do you frequently feel nervous, anxious, or on edge? Are you frequently unable to stop or control worrying?
- Hostility: Do you frequently feel angry over little things? Do you often feel annoyed about the habits other people have?
- Type D personality: In general, do you often feel anxious, irritable, or depressed? Do you avoid sharing your thoughts and feelings with other people?

Low job demand-control, low effort-reward imbalance and/or a ´yes´ answer to one or more items was an indication of a likely psychosocial risk factor.

Other measures

With self-administrated questionnaires and medical records, information was gathered about diseases diagnosed by a physician, years of education, marital status (cohabiting or not) and quality of sleep (good or not good). Alcohol consumption was assessed with the 3-item Alcohol Use Disorders Identification Test (AUDIT-C) with a cutoff of 5 for harmful drinking (26).

Informed consent

The study protocol and consent forms were reviewed and approved by the Ethics Committee of the Hospital District of Southwest Finland. All participants signed a written informed consent for the project and subsequent medical research.

Statistical analysis

Statistical significances for the unadjusted hypothesis of linearity across categories of total work engagement and CVH metrics were evaluated by using the Cochran-Armitage test for trend and

analysis of variance with an appropriate contrast. Adjusted hypothesis of linearity (orthogonal polynomial) were evaluated using generalized linear models (e.g. analysis of co-variance and logistic models) with appropriate distribution and link function. Models included age and years of education as covariates. In the case of violation of the assumptions (e.g. non-normality), a bootstrap-type method was used (10 000 replications) to estimate the standard error. Multivariate linear regression analysis was used to identify the appropriate predictors of continuous work engagement using standardized regression coefficient Beta (β). The Beta value is a measure of how strongly each predictor variable influences the criterion (dependent) variable. The Beta is measured in units of standard deviation. Cohen's standard for Beta values above 0.10, 0.30 and 0.50 represent small, moderate and large relationships, respectively (27). The normality of variables was evaluated by the Shapiro-Wilk W test. All analyses were performed using STATA 14.1.

The STROBE Guidelines were followed in this paper.

Results

We evaluated 726 female employees (mean age 48 ± 10 years). Table 1 shows a general overview of the characteristics of the study subjects.

Table 1. A general overview of the characteristics of the study subjects

Variables	
Age, mean (SD)	48.0 (9.9)
Education years, mean (SD)	13.9 (2.7)
AUDIT-C, mean (SD)	2.9 (1.7)
Height (cm), mean (SD)	165.1 (5.9)
Weight (kg), mean (SD)	72.8 (14.1)
Sum of the total 7 ideal CVH metrics, mean (SD)	3.6 (1.3)
Nonsmoking, n (%)	635 (87.5)
Body mass index (kg/ m^2), mean (SD)	26.7 (4.8)
Healthy diet, n (%)	258 (35.5)
Physical activity at goal, n (%)	290 (39.9)
Blood pressure systolic (mmHg), mean (SD)	131.3 (17.0)
Blood pressure diastolic (mmHg), mean (SD)	85.7 (10.5)
Total cholesterol (mmol/l), mean (SD)	5.3 (0.9)
HbA1c (mmol/mol), mean (SD)	5.5 (0.5)
Sum of the total 6 psychosocial risk factors, mean (SD)	1.5 (1.5)
Work ability score, (NRS), mean (SD)	8.2 (8.2)
Work engagement, mean (SD)	
Total	4.8 (0.9)
Vigor	4.8 (1.0)
Dedication	4.9 (1.0)
Absorption	4.7 (1.1)

Abbreviations: SD; standard deviation, AUDIT-C; Alcohol Use Disorders Identification Test, CVH; cardiovascular health, HbA1c; glycated hemoglobin, NRS; numeric rating scale

Of the employees, 25.2% had 5-7 CVH metrics, 53.0% had 3-4 metrics, and 21.8% had 0-2 metrics at the ideal level. The sum of ideal CVH metrics were associated linearly with work engagement driven by the positive relationship of healthy diet and physical activity with work engagement. Financial situation, good quality of sleep, and WAS were associated positively with work engagement (Table 2).

At least one psychosocial risk factor was reported by 63.3% of the female employees. The prevalence of psychosocial risk factors were as follows: depressive symptoms 18.9%, anxiety 31.4%, hostility 20.9%, type D personality 26.3%, social isolation 17.5%, and stress 31.0%. The prevalence of any psychosocial risk factor decreased linearly with work engagement (Table 2).

Table 2. Characteristics of the study subjects according to the sum of work engagement

Variables	Total work engagement				P-value*	
	Low (≤3.43) n=59	Moderate (3.44-4.53) n=151	High (4.54-5.30) n=276	Very high (>5.30) n=240	Crude	Adjusted**
Age, mean (SD)	47 (11)	48 (9)	47 (10)	49 (9)	0.53	..
Education years, mean (SD)	14.0 (2.5)	14.0 (2.6)	14.0 (2.7)	13.7 (2.8)	0.28	..
Financial situation, n (%)	27 (46)	85 (56)	175 (63)	167 (70)	<0.001	<0.001
Marital status, cohabiting, n (%)	43 (73)	111 (74)	231 (84)	180 (75)	0.59	0.55

Good quality of sleep, n (%)	36 (61)	103 (68)	196 (71)	181 (75)	0.019	0.016
AUDIT-C, mean (SD)	2.9 (2.0)	2.9 (1.7)	3.1 (1.6)	2.7 (1.8)	0.55	0.59
Working hours, hours/week, mean (SD)	41.1 (4.0)	41.2 (3.6)	41.4 (3.9)	41.9 (4.2)	0.12	0.16
Shift work, n (%)	20 (34)	55 (36)	85 (31)	71 (30)	0.20	0.12
WAS, (NRS), mean (SD)	7.2 (1.7)	7.6 (1.4)	8.2 (1.0)	8.8 (0.9)	<0.001	<0.001
Sum of ideal cardiovascular health metrics, n (%)					0.076	0.023
Unfavorable (0-2)	11 (19)	39 (26)	59 (21)	49 (20)		
Intermediate (3-4)	37 (63)	80 (53)	148 (54)	120 (50)		
Favorable (5-7)	11 (19)	32 (21)	69 (25)	71 (30)		
Ideal cardiovascular health metrics, n (%)						
Nonsmoking	48 (82)	142 (94)	237 (86)	208 (87)	0.58	0.34
Body mass index <25.0 kg/m^2	30 (51)	63 (42)	117 (42)	87 (36)	0.050	0.070
Physical activity at goal	21 (36)	48 (32)	110 (40)	111 (46)	0.008	0.006
Healthy diet	16 (27)	45 (30)	90 (33)	107 (45)	<0.001	0.001
Untreated blood pressure <120/80mmHg	12 (20)	23 (15)	52 (19)	50 (21)	0.39	0.22
Untreated total cholesterol <5.18mmol/l	26 (44)	61 (40)	121 (44)	111 (46)	0.39	0.23

Untreated HbA1c <6.0% (42 mmol/mol)	54 (92)	139 (92)	263 (95)	215 (90)	0.43	0.58
Any psychosocial risk factor, n (%)	50 (85)	107 (71)	169 (61)	134 (56)	<0.001	<0.001
Depressive symptoms	25 (42)	38 (25)	46 (17)	28 (12)	<0.001	<0.001
Anxiety	31 (53)	57 (38)	83 (30)	57 (24)	<0.001	<0.001
Hostility	23 (39)	34 (23)	57 (21)	38 (16)	<0.001	<0.001
Type D personality	30 (51)	48 (32)	67 (24)	46 (19)	<0.001	<0.001
Social isolation	15 (25)	35 (23)	36 (13)	41 (17)	0.047	0.049
Stress	32 (54)	56 (37)	85 (31)	52 (22)	<0.001	<0.001

* P for linearity

* Adjusted for age and years of education

Abbreviations: AUDIT-C; Alcohol Use Disorders Identification Test, WAS; work ability score, NRS; numeric rating scale, HbA1c; glycated hemoglobin

In the multivariate linear regression analysis, WAS had a strong positive relationship with work engagement while age, financial situation, and total cholesterol level had a small positive association. BMI, depressive symptoms, hostility, and stress had a small negative influence on work engagement (Figure 1).

Figure 2 shows that in subjects without psychosocial risk factors, total work engagement was high and stable (p-value for linearity 0.14) across the range of the sum of ideal CVH metrics. The presence of even one psychosocial risk factor had a negative relationship with work engagement.

Linearity between the presence of at least one psychosocial risk factor and work engagement was significant ($p < 0.001$) across the categories of the sum of ideal CVH metrics. The interaction between the presence of psychosocial risk factors and the sum of ideal CVH metrics was not significant ($p = 0.79$).

Discussion

According to our study, physical health is positively associated with work well-being driven by the positive relationship of a healthy diet and physical activity with work engagement. However, even one of the measured psychosocial risk factors had a negative association with the level of work engagement regardless of the sum of ideal CVH metrics.

Our finding that psychosocial risk factors have a negative relationship with work engagement is in line with previous studies reporting that employees with a high level of work engagement have lower scores on stress, anxiety and depression (12, 14-17, 28). Vigor especially, characterized by energy, mental resilience, the willingness to invest one's effort and persistence (10) was linked to decreased depression and anxiety in a 2-year follow-up study (18). Due to technological developments, the nature of work in developed countries has become less physical but more demanding mentally and emotionally, as work pace and stress have increased (29). These changes in daily working life may contribute to adverse health effects, including mental health problems and body weight gain (29). However, work can also contribute in a positive way to mental health providing psychological development, social contacts, a purpose in life and an increase in self-esteem and quality of life (29) as seen in the study where work engagement increased life satisfaction (17).

Compared to Finnish reference values (20) work engagement in our subjects was high and stable. Every fourth of our study subjects had 5-7 ideal CVH metrics, which is comparable to the US (30). Willis et al. have estimated that individuals in midlife with 5–7 ideal CVH metrics exhibited 25% lower median annual non-CVD costs and 75% lower median CVD costs in old age than those with 0–2 ideal CVH metrics (25). Leijten et al. have shown that work engagement is related to better physical health (31), which is in line with our finding of a positive relationship between the sum of ideal CVH metrics and work engagement. However, it is unclear which lifestyle-related efforts

could increase work engagement. Enhancing physical activity and fruit intake did not improve work engagement in a work place health promotion program (32), even though these were the ideal CVH metrics associated with work engagement in the present study. Our finding of an association with quality of sleep and work engagement has also been established by Hallberg et al. (15), who showed that poor sleep hygiene decreases work engagement, highlighting that work engagement has a strong health component. Even though physical health is rarely studied with work engagement, psychological studies have shown many potential factors that increase work engagement, such as social support, innovativeness, appreciation (33) and job control (34).

In our study subjects, WAS was strongly associated with higher work engagement (7.2 vs 8.8). This supports previous studies showing that work engagement has a positive influence on work ability (35-37). For example, Airila et al. (2014) showed that baseline work ability predicted work ability after a 10-year follow-up directly and indirectly via work engagement. They also demonstrated that better job resources (supervisory relations, interpersonal relations, task resources) and self-esteem were related to increased work engagement and work ability. Work ability is the degree to which a worker, given his/her health, is physically and mentally able to cope with the demands at work (38). Work engagement is more dependent on mental aspects, whereas work ability also involves the subject's physical condition. Our result still has to be interpreted with caution, because the relationship can also be bidirectional.

At an organizational level, occupational health care should actively seek for psychosocial risk factors, but also focus on enhancing a healthy lifestyle, i.e. factors proven to have a positive relationship with work engagement. To increase work engagement at an individual level it seems that the simplest rule is to eat healthy, exercise at a moderate-to-vigorous level, focus on social life and embrace positive attitude. Future studies should focus on individual physical health metrics (e.g. physical activity, blood pressure) evaluated as metric variables, since in this study the ideal CVH metrics are dichotomous variables with strict goals and this can potentially explain the lack of

any associations with work engagement other than those of diet and physical activity. Furthermore, there is a need for longitudinal studies to explore relationships between physical and mental cardio-protective factors with work engagement.

We acknowledge some limitations of the study. The causality of work engagement with psychosocial risk factors or lifestyle factors cannot be determined due to the cross-sectional nature of our study. A common source bias might explain the relationship with work engagement and mental health, because the construct of work engagement resembles more a mental health context than the construct of physical health. Diet and physical activity were measured by self-assessment, which may be influenced by social desirability. A possible healthy worker effect (39) can emerge, as subjects out of the workforce were not studied. This may cause bias in the generalizability of the results. In addition, the exact participation rate for the study is impossible to estimate, because we cannot know how many of the employees actually received or read the invitation e-mail. To screen for psychosocial risk factors, we used simple core questions (9). Answering ´yes´ to one of these questions does not imply that the person actually has a risk factor; e.g. not all people living alone are socially isolated. However, giving an affirmative answer to either one of the two core questions on depression used in the present study, has been shown to be as effective as using longer screening instruments (40). However, the single-item question WAS, has a strong association with the Work Ability Index and is trustworthy in evaluating work ability (41). The strengths of the study are that we could take into account several aspects of life in many occupational groups. Anthropologic measures were conducted by trained medical staff, and the laboratory tests performed were up-to-date.

Conclusions

Our results suggest that both physical and mental cardio-protective factors have a positive relationship with work engagement. However, the presence of even one psychosocial risk factor has potential to associate negatively with work engagement regardless of the sum of ideal CVH metrics. Longitudinal studies are needed to confirm the direction of these associations.

Declaration of conflicting interests:

The authors declare that there are no conflicts of interest.

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Author contributions:

VV, HK and PK contributed to the conception or design of the work, and to the acquisition, analysis, or interpretation of data for the work. VV and PK drafted the manuscript. All authors critically revised the manuscript and gave final approval and agree to be accountable for all aspects of work ensuring integrity and accuracy.

Data sharing statement:

There is no additional unpublished data from this study. The data can be accessed by Prof. Päivi Korhonen (paikor@utu.fi).

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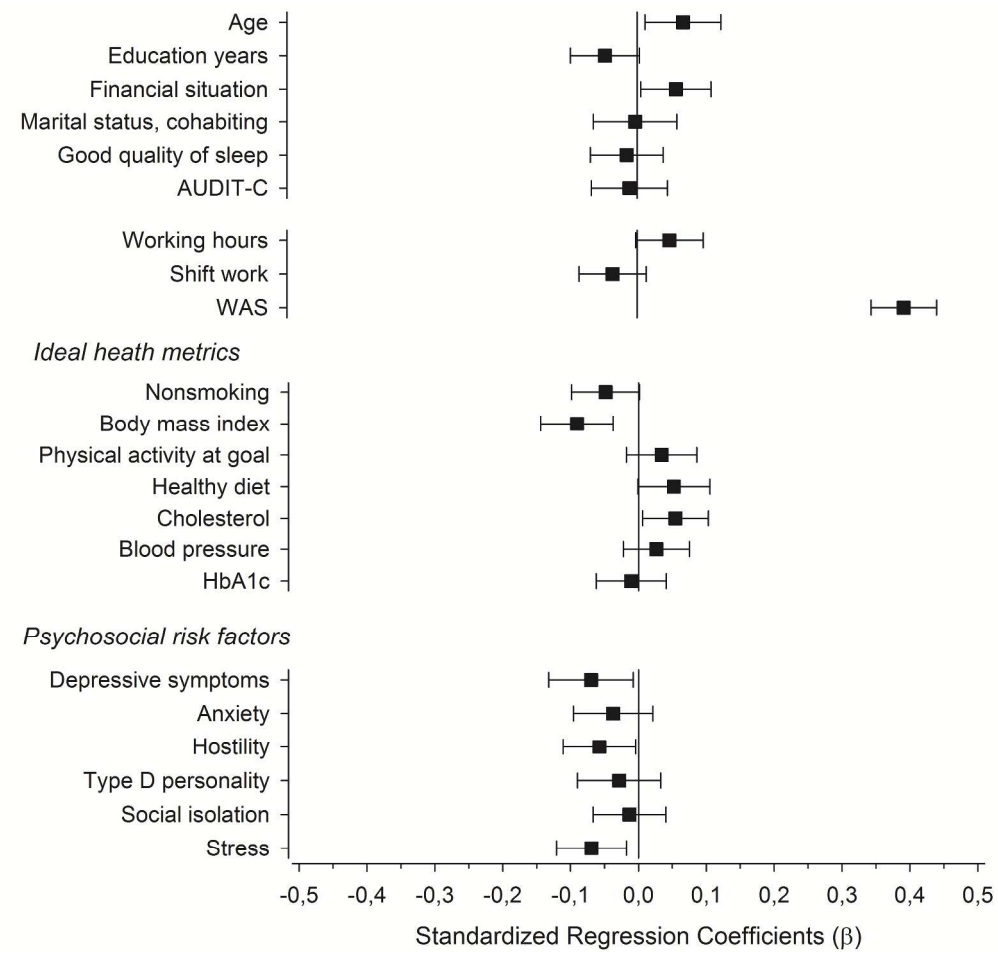
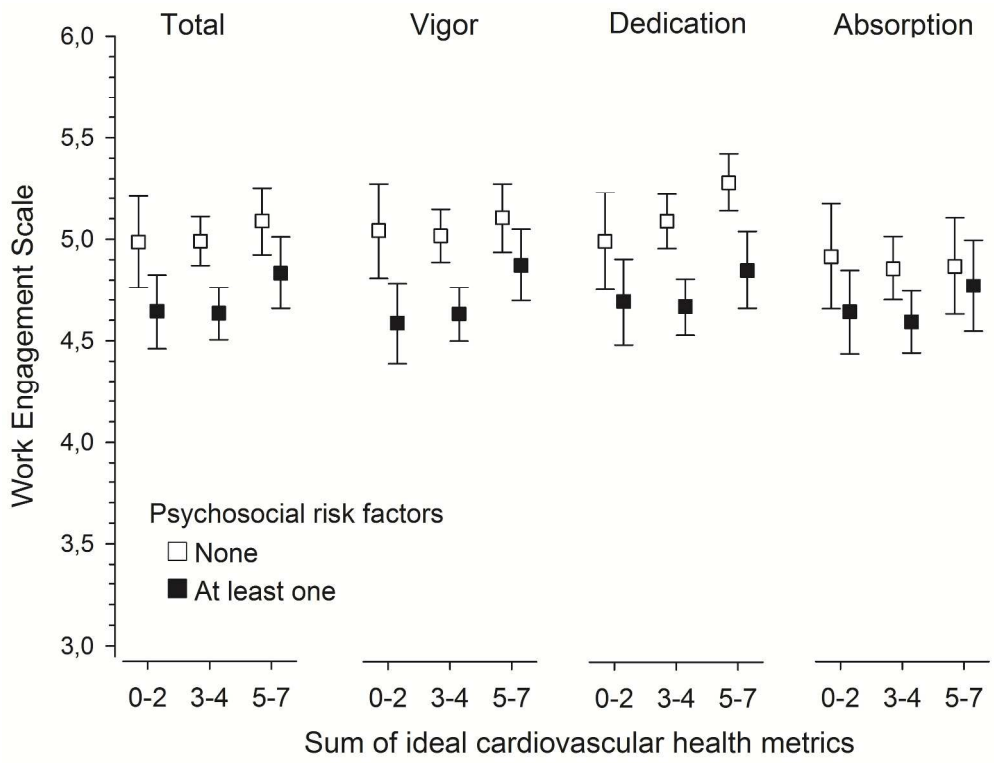
Figure 1. Predictors of continuous work engagement (β-values with 95% confidence intervals) using multivariate regression.

Figure 2. Mean with 95% confidence intervals of total work engagement and its subscales (adjusted for age and education years) according to the sum of ideal cardiovascular health metrics and the prevalence of psychosocial risk factors among the female employees.



Predictors of continuous work engagement (β-values with 95% confidence intervals) using multivariate regression.



Mean with 95% confidence intervals of total work engagement and its subscales (adjusted for age and years of education) according to the sum of ideal cardiovascular health metrics and the prevalence of psychosocial risk factors among the female employees.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract, see page 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found, see page 2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported see page 4
Objectives	3	State specific objectives, including any prespecified hypotheses see page 5
Methods		
Study design	4	Present key elements of study design early in the paper see pages 1,2,6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection see pages 2, 6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants see page 6
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable see pages 6-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group see pages 6-9
Bias	9	Describe any efforts to address potential sources of bias see page 10
Study size	10	Explain how the study size was arrived at see page 6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding, see page 10
		(*b*) Describe any methods used to examine subgroups and interactions see page 10
		(*c*) Explain how missing data were addressed see page 6
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses see page 10

Continued on next page

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed, see page 11
		(b) Give reasons for non-participation at each stage --
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders, see page 22-24 (table 1)
		(b) Indicate number of participants with missing data for each variable of interest --
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures see page 22 (table 1)
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included, see page 22 (table 1)
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses see page 11 results
Discussion		
Key results	18	Summarise key results with reference to study objectives see page 12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias see page 14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence see page 14
Generalisability	21	Discuss the generalisability (external validity) of the study results see page 14
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based, see page 16

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.