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Ideal cardiovascular health and quality of life among Finnish municipal employees

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ABSTRACT

Ideal cardiovascular health has been defined by the American Heart Association as the absence of clinically manifest cardiovascular disease together with the presence of favorable levels of cardiovascular health metrics. The ideal metrics are hard to achieve and the aim of this study was to assess the association between favorable cardiovascular health and perceived overall quality of life (QoL).

A cross-sectional study was conducted in Finland among 836 employees in 2014 (732 women, 104 men, mean age 48 (SD 10) years) from ten municipal work units. The ideal metrics were evaluated with a physical examination, laboratory tests, medical history and self-administered questionnaires. The cardiovascular health was categorized into three groups by achievement of the ideal metrics. QoL was assessed with the EUROHIS-QOL 8-item index.

The prevalence of having 5–7 of the ideal metrics was 25.1% (210), of having 3–4 it was 53.6% (448) and for 0–2 it was 21.3% (178). The EUROHIS-QOL mean score among all participants was 3.92 (SD 0.54). The EUROHIS-QOL mean score had a positive association with the sum of ideal metrics, and was 3.72, 3.91 and 4.10 among subjects with 0–2, 3–4 and 5–7 ideal metrics, respectively. Furthermore, poor sleep quality and disease burden had a significant negative association with QoL.

A favorable cardiovascular health status together with good sleep quality seems to have a clear association with overall quality of life among employees in municipal work units.

1. Introduction

Noncommunicable diseases (NCDs) are the leading cause of deaths worldwide and the majority of these deaths are caused by cardiovascular disease (CVD) (Mendis et al., 2015). To prevent and control NCDs, the World Health Organization (WHO) has launched a global action plan focusing on major risk factors for CVD (World Health Organization, 2013). Furthermore, the American Heart Association (AHA) has introduced a concept of 'Ideal cardiovascular health', with cut-off values for optimal levels of cardiovascular (CV) health metrics. The concept is defined by the absence of clinically manifest CVD together with the presence of favorable health behaviors and health factors. To achieve optimal levels of all these health metrics, the person should be non-smoking, have a normal body mass index (BMI), a healthy diet and fulfil the recommendations for physical activity. He/she should have untreated blood pressure < 120/80 mmHg, untreated total cholesterol < 5.18 mmol/l (< 200 mg/dl) and a fasting plasma glucose of < 5.55 mmol/l (< 100 mg/dl) (Lloyd-Jones et al., 2010).

However, the ideals of CV health are hard to achieve. In the US only 0.1% - 2% of adults reach the ideal levels in all 7 metrics (Folsom et al., 2011; Yang et al., 2012). In Finland 9% of women and 3% of men aged 25–74 years reach at least 5 ideal metrics (Peltonen et al., 2014). The benefit of striving for these ideals seems to be significant, with reference to CVD and even all-cause mortality (Yang et al., 2012). Positive association between favorable CV health and health-related quality of life (HRQoL) in the US adult population has also been reported previously (Allen et al., 2015; Odom et al., 2016). In these studies HRQoL was assessed using an HRQoL4-instrument, which focused on

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the loss of healthy days caused by physical or mental illness (Allen et al., 2015; Odom et al., 2016). To date, however, data are sparse on the association between ideal CV health and perceived overall quality of life (QoL).

Despite the indisputable benefits of healthy habits, we are aware that some patients become very stressed about lifestyle recommendations. Although even vigorous physical activity seems to be beneficial for reducing stress and improving mental health in young adults (Gerber et al., 2014; VanKim and Nelson, 2013), we hypothesized that striving for strict health ideals, such as recommended level of physical activity, might provoke stress, especially among individuals working full time. This could even reduce their overall QoL and, in fact, exacerbate the difficulty in achieving these metrics. The aim of this study was to evaluate the association between favorable CV health, assessed with a modified version of the 'ideal CV health' concept, and perceived overall QoL in an employed population.

2. Methods

2.1. Participants

This cross-sectional study was part of the PORTAAT study (PORi To Aid Against Threats) conducted among employees of the city of Pori (83,497 inhabitants in 2014) in southwestern Finland in 2014. The participating work units were selected by the chief of the Welfare Unit of Pori. Invitations and study information were sent to employees by e-mail by the managers of the ten selected work units (total number of employees 2570). The employees willing to participate contacted the study contact person at their work unit, who then sent their contact information to the study nurse. There were no exclusion criteria. The population invited to participate in the study consisted of the active work force, which already excluded for example persons with significant ongoing illnesses. A total of 836 employees (104 males, 732 females) responded, the gender distribution corresponding to the standard gender distribution of the Pori employees. Respondents were invited to an appointment to enroll with the study nurse. The participants' occupations included librarians, museum employees, janitors, computer workers, social workers, nurses, physicians, administrative officials, and general office staff.

2.2. Ideal cardiovascular health metrics

Smoking status was assessed by a questionnaire. Non-smoking 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 0.1 kg with calibrated scales and height to the nearest 0.5 cm with a wall-mounted stadiometer. 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 about the frequency and duration of leisure time and commuting activities in a typical week. Fulfilling the recommendation for physical activity was defined as engaging in ≥150 min per week of moderately intense activities or ≥75 min per week of vigorously intense activities (Lloyd-Jones et al., 2010).

Information about the diet was collected with a food-frequency questionnaire. Daily consumption of vegetables, fruits, whole grains, unsaturated dietary fats, and white meat (poultry, fish) at least three times a week was considered a healthy diet. Intake of the ideal level of each dietary component was scored with one point for a range of 0–5. The dietary metric was considered ideal, if a score of 4–5 was achieved (Veromaa et al., 2017).

Blood pressure (BP) was measured by a study nurse with an automatic validated blood pressure monitor with subjects in a sitting posture, after resting at least 5 min. Two readings taken at intervals of at least 2 min were measured, and the mean of these readings was used in the analysis. BP was considered ideal if the systolic BP was < 120 mmHg and the diastolic BP was < 80 mmHg untreated, or treated to goal with primary preventive medication.

Laboratory tests were determined on blood samples which were obtained after at least 8 h of fasting. Total cholesterol was measured enzymatically (Architect c4000/c8000). The ideal total cholesterol was < 5.18 mmol/l (< 200 mg/dl). Glucose tolerance was measured with glycated hemoglobin (HbA1c) which was analyzed using High Performance Liquid Chromatography -method, HPLC, (Tosoh HLC-723G7 (G7)). The AHA metric uses fasting plasma glucose 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 (Selvin et al., 2007). Normoglycemia was defined as HbA1c < 42 mmol/mol (< 6.0%) (International Expert Committee, 2009). Both total cholesterol and glucose tolerance were categorized as ideal, if the goal levels were achieved either untreated or with primary preventive medication.

The ideal metrics were defined as binary variables, the participants either achieving the ideal or not. We used a modified version of the classification, where BP, total cholesterol and glucose tolerance treated to goal were also regarded as ideal. This was based on the European Guidelines on CVD prevention (Piepoli et al., 2016), where these medications are in non-complicated cases handled as primary prevention for CVD. The metrics were grouped into three categories by achievement of 0–2, 3–4 or 5–7 of them. This classification is based on previous research on AHA ideals, where it was used to describe poor/unfavorable (0–2 ideal CV health metrics), intermediate (3–4) and ideal/favorable (5–7) levels of cardiovascular health.(Willis et al., 2015)

2.3. Quality of life

QoL was assessed with the EUROHIS-QOL 8-item index (Power, 2003). This is a shortened version of the WHOQOL-Bref – scale (THE WHOQOL GROUP, 1998; WHOQOL Group, 1998). The EUROHIS-QOL instrument has been validated in several European countries (Schmidt et al., 2006). The participants of the present study answered the questions (as described in Table 2) at home before the baseline examination. Every question was scored from 1 to 5 (1 for very poor and 5 for very good). All scores were then added together and divided by 8 (the sum of the questions) to obtain the EUROHIS-QOL mean score (Schmidt et al., 2006).

2.4. Other measures

Information was gathered using self-administered questionnaires and medical records concerning diseases diagnosed by a physician, medication used regularly, marital status (cohabiting or not), having children < 18 years of age, education level (vocational school, college-level education, university-level education), sleep quality (very good, good, poor or very poor), and sleep duration. Alcohol consumption was assessed using the 3-item Alcohol Use Disorders Identification Test (AUDIT-C) with a cut-off of 5 points for harmful alcohol use in women and 6 points in men (Aalto et al., 2006; Bush et al., 1998; Tuunanen et al., 2007). Disease burden was defined as having at least one chronic disease diagnosed by a physician.

2.5. Statistical analysis

Means with standard deviations (SD) are presented for numerical variables and counts with percentages (%) for categorical variables in Tables 1 and 2. Association between categorical baseline characteristics and gender was evaluated with a chi-square test or with a two-sample *t*-test for numerical variables with an assumption of equal variances

Table 1
Characteristics of the participants of the PORTAAT study conducted in The City of Pori, Finland in 2014.

	All n = 836	Females n = 732	Males n = 104	p-Value[a]
Age mean, years, (SD)	48.2 (10.0)	48.0 (9.8)	49.7 (8.9)	0.085
Cardiovascular health profiles, n (%)				0.069
Poor (0–2 metrics)	178 (21.3)	149 (20.4)	29 (27.9)	
Intermediate (3–4 metrics)	448 (53.6)	391 (53.4)	57 (54.8)	
Ideal (5–7 metrics)	210 (25.1)	192 (26.2)	18 (17.3)	
Individual ideal health metrics, n (%)				
Non-smoking	722 (86.4)	635 (86.7)	87 (83.7)	0.39
Body mass index < 25.0 kg/m^2	322 (38.5)	297 (40.6)	25 (24.0)	0.001
Adequate physical activity[b]	334 (40.0)	290 (39.6)	44 (42.3)	0.60
Healthy diet[c]	282 (33.7)	258 (35.2)	24 (23.1)	0.014
Total cholesterol < 5.18 mmol/l (< 200 mg/dl)	390 (46.7)	341 (46.6)	49 (47.0)	0.92
Blood pressure < 120/80 mmHg	160 (19.1)	152 (20.8)	8 (7.7)	0.002
B-HbA1c < 42 mmol/mol (< 6.0%)	783 (93.7)	691 (94.4)	92 (88.5)	0.020
Cardiovascular medication, n (%)				
Statins	53 (6.3)	37 (5.1)	16 (15.4)	< 0.001
Antihypertensive medication	181 (21.7)	155 (21.2)	26 (25.0)	0.38
Diabetes medication	35 (4.2)	31 (4.2)	4 (3.8)	0.85
Disease burden[d], n (%)	503 (60.2)	441 (60.3)	62 (59.6)	0.90
Harmful alcohol use, n (%)	202 (24.3)	163 (22.4)	39 (37.9)	0.001
Cohabiting, n (%)	657 (78.6)	570 (77.9)	87 (83.7)	0.18
Children < 18 years, n (%)	311 (37.5)	269 (37.1)	42 (40.4)	0.51
Quality of sleep, n (%)				0.26
Very good	99 (12.0)	81 (11.2)	18 (17.5)	
Good	495 (60.1)	430 (59.6)	65 (63.1)	
Poor	208 (25.2)	189 (26.2)	19 (18.4)	
Very poor	20 (2.4)	19 (2.6)	1 (1.0)	
Education, n (%)				0.71
Vocational school	26 (3.2)	23 (3.2)	3 (2.9)	
College-level	429 (52.1)	379 (52.6)	50 (48.5)	
University-level	368 (44.7)	318 (44.2)	50 (48.5)	
EUROHIS-QOL, mean score (SD)	3.92 (0.54)	3.93 (0.53)	3.87 (0.56)	0.26

B-HbA1c = glycated hemoglobin.
EUROHIS-QOL = EUROHIS-QOL 8-item index.
SD = standard deviation.
[a] Difference between males/females.
[b] Engaging in ≥150 min per week of moderately intense activities or ≥75 min per week of vigorously intense activities.
[c] Daily consumption of vegetables, fruits, whole grains, unsaturated dietary fats, and white meat (poultry, fish) at least three times a week was considered as a healthy diet. Intake of the ideal level of each dietary component was scored with one point for a range of 0–5. The dietary metric was considered as ideal, if a score of 4–5 was achieved.
[d] At least one chronic disease diagnosed by a physician.

(Table 1). Furthermore, to test the association between classified CV health (poor, intermediate or ideal) and characteristics (age, gender, disease burden, cohabiting, children < 18 years, sleep quality, education and items of the EUROHIS-QOL) separately, a one-way analysis of variance or a chi-square test was used (Table 2). Finally, a multi-way analysis of co-variance was created for a EUROHIS-QOL total score including age, gender, cohabiting, education, sleep quality, CV health as classified and disease burden. F values and degrees of freedom from this model are presented in Table 4. Confidence intervals (95%) for means were calculated and are presented in Table 3. Normality assumption was checked visually together with a Shapiro Wilks test. Model based means were estimated from the model and in a case where the categorical factor had more than two categories, the adjusted means between the categories were compared and these p-values were corrected with Tukey's method. All statistical tests were performed as 2-sided, with a significance level set at 0.05. The analyses were performed using an SAS System, version 9.4 for Windows (SAS Institute Inc., Cary, NC, USA).

2.6. Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study protocol and consent forms were reviewed and approved by the Ethics Committee of the Hospital District of Southwest Finland (ETMK 43/180/2013).

2.7. Informed consent

Written informed consent was obtained from all individual participants included in the study.

3. Results

The study cohort consisted of 836 employees with a mean age of 48 (SD 10) years, 87.6% of whom were female. The response rate in the study was 32.5%. Table 1 displays the characteristics of the participants according to gender. The EUROHIS-QOL mean score was 3.92 (SD 0.54) with no significant difference between males and females (p = 0.26). An ideal BMI, diet, BP and glucose tolerance was found more often in the females than the males (all p-values < 0.02). Harmful alcohol use was more common in men (p = 0.001) and the men used statins more often than women (p < 0.001) (Table 1). Subjective sleep quality was associated with sleep duration (p < 0.0001). The mean average sleeping time increased with better sleep quality and was 5.3 h in very poor sleepers, 6.4 h in poor sleepers, 7.2 h in good sleepers and 7.4 h in very good sleepers. Significant differences in sleeping time were present between all classes of subjective sleep quality (all p-values < 0.02).

Table 2
Characteristics of the participants according to the cardiovascular health profiles. PORTAAT study conducted in The City of Pori, Finland in 2014.

	Cardiovascular health profiles			
	Poor 0–2metrics (n = 178)	Intermediate 3–4 metrics (n = 448)	Ideal 5–7 metrics (n = 210)	p-Value
Age, years, mean (SD)	51.42 (8.2)	48.61 (9.4)	44.48 (10.5)	< 0.0001
Females, n (%)	149 (83.7)	391 (87.3)	192 (91.4)	0.069
Disease burden[a], n (%)	111 (62.4)	279 (62.3)	113 (53.8)	0.093
Harmful alcohol use, n (%)	54 (30.7)	97 (21.8)	51 (24.3)	0.067
Cohabiting, n (%)	127 (71.4)	355 (79.2)	175 (83.3)	0.015
Children < 18 years, n (%)	54 (31.4)	158 (35.3)	99 (47.1)	0.0025
Quality of sleep, n (%)				0.015
Very good	9 (5.2)	55 (12.4)	35 (16.8)	
Good	102 (59.3)	273 (61.6)	120 (57.7)	
Poor	55 (32.0)	106 (23.9)	48 (23.1)	
Very poor	6 (3.5)	9 (2.0)	5 (2.4)	
Education, n (%)				0.00020
Vocational school	10 (5.9)	15 (3.4)	1 (0.5)	
College-level	97 (56.7)	242 (54.5)	90 (43.3)	
University-level	64 (37.4)	187 (42.1)	117 (56.3)	
EUROHIS-QOL, mean score (95% CI)	3.72 (3.64–3.91)	3.91 (3.86–3.96)	4.10 (4.04–4.16)	< 0.0001
Items of the EUROHIS-QOL, mean score (95% CI)				
How would you rate your quality of life?	3.70 (3.60–3.81)	3.89 (3.83–3.95)	4.02 (3.94–4.10)	< 0.0001
How satisfied are you with your health?	3.37 (3.22–3.53)	3.68 (3.56–3.76)	3.99 (3.88–4.10)	< 0.0001
How satisfied are you with your ability to perform your daily living activities?	3.81 (3.69–3.93)	4.05 (3.98–4.13)	4.30 (4.21–4.39)	< 0.0001
How satisfied are you with yourself?	3.51 (3.39–3.64)	3.77 (3.70–3.84)	3.96 (3.88–4.04)	< 0.0001
How satisfied are you with your personal relationships?	3.91 (3.80–4.03)	4.04 (3.97–4.11)	4.12 (4.01–4.22)	0.0098
How satisfied are you with the conditions of your living place?	4.23 (4.13–4.33)	4.30 (4.23–4.36)	4.40 (4.31–4.50)	0.011
Do you have enough energy for everyday life?	3.68 (3.56–3.81)	3.84 (3.76–3.93)	4.09 (3.97–4.39)	< 0.0001
Have you enough money to meet your needs?	3.53 (3.38–3.68)	3.74 (3.65–3.83)	3.93 (3.79–4.06)	0.0004

CI = confidence interval.
EUROHIS-QOL = EUROHIS-QOL 8-item index.
SD = standard deviation.
[a] At least one chronic disease diagnosed by a physician.

The prevalence of having an ideal CV health (5–7 ideal health metrics) was 25.1% (n = 210), intermediate CV health (3–4 metrics) 53.6% (n = 448), and poor CV health (0–2 metrics) 21.3% (n = 178) (Table 1). The individuals with more favorable CV health tended to be younger, cohabiting, and better educated. They typically had children < 18 years of age and had better sleep quality (Table 2). The association between age and CV health profiles was significant both with age groups and with age as a continuous variable (both p-values < 0.0001). The proportion of participants achieving 5–7 ideal metrics decreased in the older age groups. It was 36.5% in participants < 45 years of age, 21.8% in 45–54 years of age and 16.9% in participants > 55 years of age.

The EUROHIS-QOL mean score increased according to the total number of ideal CV health metrics. The scores were 3.72, 3.91 and 4.10 among subjects with poor, intermediate and ideal CV health, respectively (p < 0.0001). Additionally, all subcategories of CV health differed significantly from each other (all p-values < 0.0003). The EUROHIS-QOL mean score was significantly higher in participants having a healthy diet, a recommended level of physical activity, normal BMI, normal blood sugar levels and who were non-smoking, compared to those who did not achieve these ideals (Table 3). The EUROHIS-QOL mean score was also higher among those who were cohabiting, had good sleep quality, university-level education and did not have chronic illnesses (Table 3).

Further, the mean scores of the individual items of the EUROHIS-QOL questionnaire increased with more favorable CV health profiles (Table 2). With poor CV health, the mean values varied between 3.4 and 4.2 while with ideal CV health the mean values varied between 3.9 and 4.4. A significant positive association was present in all 8 items; in addition, most of the pairwise comparisons between QoL mean scores in the three different CV health categories showed significant differences (data not shown).

The significant explanatory variables affecting QoL (Table 3) were entered in the multiway analysis of co-variance and adjusted with gender and age. Good QoL was positively associated in this model with good sleep quality, favorable CV health profile, absence of a disease burden, higher age, university-level education and cohabiting. Sleep quality was the most important factor affecting QoL. The difference of QoL mean score estimates between very good and very poor sleep quality was 0.70 units. For the CV health profiles the estimates varied 0.32 units between the poor and the ideal. Among those with a disease burden the estimate was 0.15 units lower than in the healthy participants (Table 4).

4. Discussion

The main findings in this study were that overall QoL increased with better CV health profiles, and good subjective sleep quality showed an even stronger relationship with overall QoL in municipal employees. Other significant predictors of good QoL were the absence of a disease burden, older age, cohabiting and a university-level education.

To our knowledge, there are only two previous studies about the association between ideal CV health and QoL. Allen et al. (2015) and Odom et al. (2016) reported a positive association between ideal CV health and HRQoL assessed with the US Centers for Disease Control and Prevention (CDC) “Healthy Days” –instrument (HRQoL4). They showed that ideal CV health is associated with fewer physically and mentally unhealthy days.

With the EUROHIS-QOL instrument, we managed to show that a favorable CV health is not only associated with good HRQoL, but also good QoL in general. This indicates that the effort for a more healthy life is widely beneficial. The approach to QoL with the EUROHIS-QOL instrument is consistently subjective, which differs from the HRQoL4-instrument's quantifiable nature and emphasizes the patient-centered

Table 3
EUROHIS-QOL 8-item index mean scores with 95% confidence intervals for cardiovascular health profiles, individual health metrics and other characteristics of the participants. PORTAAT study, conducted in The City of Pori, Finland in 2014.

	EUROHIS-QOL mean scores	95% confidence intervals	p-Value
Cardiovascular health profiles			< 0.0001[a]
Poor (0–2 metrics)	3.72	3.64–3.91	
Intermediate (3–4 metrics)	3.91	3.86–3.96	
Ideal (5–7 metrics)	4.10	4.04–4.16	
Smoking			0.038
No	3.86	3.78–3.94	
Yes	3.75	3.63–3.87	
Body mass index			0.0002
< 25.0 kg/m^2	3.88	3.78–3.98	
≥ 25.0 kg/m^2	3.74	3.64–3.83	
Physical activity[b]			< 0.0001
Recommended	3.89	3.79–3.99	
Low	3.72	3.63–3.81	
Diet[c]			< 0.0001
Healthy	3.89	3.79–3.99	
Unhealthy	3.73	3.63–3.81	
Total cholesterol mmol/l (mg/dl)			0.41
< 5.18 mmol/l (< 200 mg/dl)	3.82	3.73–3.91	
≥ 5.18 mmol/l (≥ 200 mg/dl)	3.79	3.70–3.89	
Blood pressure			0.082
< 120/80 mmHg	3.77	3.65–3.88	
≥ 120/80 mmHg	3.84	3.76–3.93	
B-HbA1c			0.0007
< 42 mmol/mol	3.93	3.87–3.99	
≥ 42 mmol/mol	3.68	3.53–3.83	
Disease burden[d]			< 0.0001
No	4.03	3.97–4.09	
Yes	3.85	3.80–3.90	
Harmful alcohol use			0.81
No	3.94	3.87–4.01	
Yes	3.91	3.87–3.96	
Cohabiting			0.031
Yes	3.94	3.90–3.98	
No	3.84	3.76–3.92	
Children < 18 years			0.34
Yes	3.90	3.84–3.96	
No	3.93	3.89–3.98	
Quality of sleep			< 0.0001[e]
Very good	4.20	4.10–4.30	
Good	3.98	3.94–4.03	
Poor	3.70	3.64–3.78	
Very poor	3.42	3.20–3.64	
Education			0.0039
Vocational school	3.76	3.55–3.96	
College-level	3.88	3.83–3.93	
University-level	3.99	3.93–4.04	

B-HbA1c = glycated hemoglobin.
EUROHIS-QOL = EUROHIS-QOL 8-item index.
[a] All pairwise comparisons p ≤ 0.0003.
[b] Engaging in ≥ 150 min per week of moderately intense activities or ≥ 75 min per week of vigorously intense activities.
[c] Daily consumption of vegetables, fruits, whole grains, unsaturated dietary fats, and white meat (poultry, fish) at least three times a week was considered as a healthy diet. Intake of the ideal level of each dietary component was scored with one point for a range of 0–5. The dietary metric was considered as ideal, if a score of 4–5 was achieved.
[d] At least one chronic disease diagnosed by a physician.
[e] All pairwise comparisons < 0.05.

aspect in our results. The difference of EUROHIS-QOL mean scores between ideal (5–7 ideal health metrics) and poor (1–2 metrics) CV health was 0.32 units after adjustment with several factors (Table 4). This difference can be considered to be clinically significant, compared to previous studies using the EUROHIS-QOL instrument: the mean scores among depressed populations were 0.39–0.61 units lower than in non-depressed populations (Da Rocha et al., 2012) and the mean scores among chronically ill populations 0.26–0.40 units lower than in healthy populations (Schmidt et al., 2006). In this regard, our results indicating a somewhat paradoxical finding that ideal blood pressure might be associated with a lower QoL mean score, does not seem clinically significant (Table 3).

With regard to the Finnish national reference values (Koskinen et al., 2012), the EUROHIS-QOL mean scores in our study population were approximately on the same level. The reference values in Finland are 4.0 in men and 4.0–4.1 in women aged 30–65 years (Koskinen et al., 2012). In the present study, the mean score was 3.87 in men and 3.93 in women, with no significant difference between genders. When compared to a Finnish population-based study (Peltonen et al., 2014), the proportion of participants reaching 5–7 ideal health metrics was high in our study population, where 17% of men and 26% of women reached this favorable CV health status. Only 3% of men and 9% of women aged 30–74 years did so in a random sample of the Finnish population (Peltonen et al., 2014). This difference can be caused by the younger mean age of the participants compared to the reference population, and since we used a modified classification of the BP, cholesterol and glucose tolerance metrics, this may have increased the proportion of participants achieving an ideal CV health profile. Further, our study was conducted among employees, i.e. mostly fortunate individuals. There is some evidence that favorable CV health status is associated with a lower risk of depression (Li et al., 2015), which raises the possibility of depression being one of the mediating factors in the association between QoL and CV health. However, the prevalence of previously diagnosed depression was low (2.5%) in our study population, which may decrease its importance in our case. Nevertheless, the findings of the present study may only be generalized to an employed, working-age population.

To describe sleep quality, we chose a single question about subjective sleep quality from the Pittsburgh Sleep Quality index, because it has previously been shown to be a strong predictor of QoL also when adjusted with psychosocial risk factors, such as depression (Marques et al., 2017). This question was chosen over a longer questionnaire because it could also be used at a normal physician's appointment. Interestingly, good sleep quality transpired to be the most powerful factor predicting good QoL in this study. This significant association remained in the multivariable model. In several previous studies poor sleep quality has been found to be associated with poorer QoL (Chang et al., 2007; Eryilmaz et al., 2005; Liu et al., 2011; Palhares et al., 2014), but the nature of the connection is incompletely understood. In some studies, depression is thought to be the mediating factor (Eryilmaz et al., 2005), but there is also evidence, that sleep quality could be an independent factor affecting QoL (Marques et al., 2017). As the prevalence of diagnosed depression was low (2.5%) in this study, it may not be the only explanation behind the connection. However, more research is needed to clarify the mechanisms and probable mediating factors that link sleep quality so closely to experienced QoL.

The major limitation of our study is its cross-sectional nature. We are unable to answer the question of whether the good QoL is a result of a healthy lifestyle or vice versa. However, data in previous literature support the adverse causal effect of poor socioeconomic status on CV health (Clark et al., 2009), and socioeconomic factors are known to be strong determinants of QoL (Mielck et al., 2011). In our data, the finding that participants with higher education reached a better CV health level (Table 2) and QoL (Table 3) compared to those with lower education, supported this effect. Another limitation in this study is the response rate of 32.5%, which can cause selection bias. It is well known, that people with more risk behaviors are less willing to attend health surveys because they are afraid of receiving negative feedback. In our case, the main purpose for the PORTAAT study, explained to the

Table 4
Predictors of quality of life in multiway analysis of co-variance. PORTAAT study conducted in The City of Pori, Finland in 2014.

Predictors of quality of life	Model based EUROHIS-QOL mean scores (95% confidence intervals)	Degrees of freedom	F-score	p-Value	p-Values for group comparisons	
Quality of sleep		3	29.63	< 0.0001		
Very good	4.09 (3.97–4.21)				Very good vs. Good	0.0041
Good	3.91 (3.82–4.00)				Very good vs. Poor	< 0.0001
Poor	3.63 (3.53–3.73)				Very good vs. Very poor	< 0.0001
Very poor	3.39 (3.16–3.62)				Good vs. Poor	< 0.0001
					Poor vs. Very poor	0.14
Cardiovascular health profiles		2	18.26	< 0.0001		
Ideal (5–7 metrics)	3.92 (3.80–4.03)				Ideal vs. Poor	< 0.0001
Intermediate (3–4 metrics)	3.75 (3.65–3.86)				Ideal vs. Intermediate	0.0003
Poor (0–2 metrics)	3.60 (3.48–3.71)				Poor vs. Intermediate	0.0016
Disease burden[a]		1	18.92	< 0.0001		
Yes	3.68 (3.58–3.78)					
No	3.83 (3.73–3.94)					
Education		2	4.48	0.012		
Vocational school	3.70 (3.49–3.91)				Vocational vs. College	0.94
College-level	3.73 (3.65–3.82)				Vocational vs. University	0.36
University-level	3.84 (3.75–3.92)				College vs. University	0.0089
Cohabiting		1	4.31	0.038		
Yes	3.80 (3.70–3.90)					
No	3.71 (3.60–3.83)					
Gender		1	3.71	0.054		
Female	3.81 (3.72–3.90)					
Male	3.71 (3.58–3.84)					
Age, slope estimate[b] (SE)	0.0058 (0.0019)	1	8.87	0.0030		

The impact of each variable on the outcome is displayed after adjusting for all other variables.
SE = standard error.
[a] At least one chronic disease diagnosed by a physician.
[b] Slope value indicates the mean increase in EUROHIS-QOL mean score for one year older person.

participants in the invitation letter, was to discover whether stress in modern work life is affecting the employees' health. The fact that the study was not primarily examining the classical risk behaviors and risk factors of cardiovascular health may thus have reduced the bias. However, those who did not want to attend may differ from those who chose to take part in the study. Although the prevalence of depression in active work force is probably relatively low, we cannot discount that, for example, depressive symptoms may have prevented some people from attending the survey. If this is so, their QoL, sleep quality, and health habits would probably also have been worse than the non-depressive employees'. That may result in the fact that our results reflect the situation in the mainly healthy section of the work force. To test this possible bias, we compared some basic determinants of the socio-economic and health states of our participants to the Finnish population. The prevalence of smoking in our study population was comparable to working age people in Finland (13% in women and 16% in men vs. 14% and 17%, respectively (Helldán and Helakorpi, 2015)) Every fifth female in our study, as well as on the working age population was obese (BMI ≥ 30). Only men in our study population were more often obese than in Finnish working age population (31% vs.16% (Helldán and Helakorpi, 2015)). The gender distribution in our study (87.6% females) resembles the distribution among employees of the city of Pori and is close to the distribution among Finnish public sector employees (81.3% women in 2015 (Statistics Finland 2019)). However, the final analyses were also made using only the data from the female participants (data not shown) and the results remained the same as with the whole data. Nevertheless, we are unable to generalize the information from the male participants.

The strength of the study is the combination of clinical and self-reported data. The measurements were made by trained medical staff and many factors affecting QoL could be taken into account. All questionnaires were completed by the participants at home before the baseline examination was performed. With the EUROHIS-QOL instrument the approach to QoL is consistently subjective, which takes into account that good QoL can mean different conditions to different individuals.

5. Conclusions

This study supported a positive association between ideal CV health and overall QoL among municipal employees, and good sleep quality showed an even stronger relationship with better QoL in this population. These two major factors seemed to affect physical, psychological, social and environmental aspects of QoL. Thus, efforts to develop better CV health, without neglecting other components of good QoL, would be most beneficial for individual as well as for society. These results can be utilized in the promotion of CV health and well-being at a community level as well as at physicians' appointments, especially in primary or occupational health care.

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Availability of data

The datasets used and/or analyzed during the current study are available from the corresponding author on request.

Declaration of Competing Interest

The authors declare that they have no conflicting interests.

References

Aalto, Mauri, Tuunanen, Mervi, Sillanaukee, Pekka, Seppä, Kaija, 2006. Effectiveness of structured questionnaires for screening heavy drinking in middle-aged women.

Alcohol. Clin. Exp. Res. 30 (11), 1884–1888.
Allen, Norrina B., Badon, Sylvia, Greenlund, Kurt J., Huffman, Mark, Hong, Yuling, Lloyd-Jones, Donald M., 2015. The association between cardiovascular health and health-related quality of life and health status measures among U.S. adults: a cross-sectional study of the National Health and Nutrition Examination Surveys, 2001-2010. Health Qual. Life Outcomes 13 (1), 152.
Bush, Kristen, Kivlahan, Daniel R., McDonell, Mary B., Fihn, Stephan D., Bradley, Katharine A., 1998. The AUDIT alcohol consumption questions (AUDIT-C). Archives of Interal Medicine 158, 1789–1795.
Chang, Edward Wei-Chung, Tsai, Ying-Ying, Chang, Tsai-Wang, Tsao, Chao-Jung, 2007. Quality of sleep and quality of life in caregivers of breast cancer patient. Psycho-Oncology 16 (10), 950–955.
Clark, Alexander M., Desmeules, Marie, Luo, Wei, Duncan, Amanda S., Wielgosz, Andy, 2009. Reviews socioeconomic status and cardiovascular disease : risks and implications for care. Nat. Rev. Cardiol. 6 (11), 712–722.
Da Rocha, Sica, Neusa, Power, Mick J., Bushnell, Donald M., Fleck, Marcelo P., 2012. The EUROHIS-QOL 8-item index: comparative psychometric properties to its parent WHOQOL-BREF. Value Health 15 (3), 449–457.
Eryilmaz, M.M., Ozdemir, C., Yurtman, F., Cilli, A., Karaman, T., 2005. Quality of sleep and quality of life in renal transplantation patients. Transplant. Proc. 37 (5), 2072–2076.
Folsom, Aaron R., Yatsuya, Hiroshi, Nettleton, Jennifer A., Lutsey, Pamela L., Cushman, Mary, Rosamond, Wayne D., 2011. Community prevalence of ideal cardiovascular health, by the AHA definition, and relation to cardiovascular disease incidence. J. Am. Coll. Cardiol. 57 (16), 1690–1696.
Gerber, Markus, Brand, Serge, Herrmann, Christian, Colledge, Flora, Holsboer-trachsler, Edith, Pühse, Uwe, 2014. Physiology & behavior increased objectively assessed vigorous-intensity exercise is associated with reduced stress , increased mental health and good objective and subjective sleep in young adults. Physiol. Behav. 135, 17–24.
Helldán, Anni, Helakorpi, Satu, 2015. Health Behaviour and Health Among the Finnish Adult Population, Spring 2014. National Institute for Health and Welfare (THL), Tampere.
International Expert Committee, 2009. International expert committee report on the role of the A1C assay in the diagnosis of diabetes. Diabetes Care 32 (7), 1327–1334.
Koskinen, Seppo, Lundqvist, Annamari, Ristiluoma, Noora, 2012. Terveys. Toimintakyky Ja Hyvinvointi Suomessa 2011.
Li, Zhikun, Yang, Xin, Wang, Anxin, Qiu, Jing, Wang, Wei, Song, Qiaofeng, 2015. Association between ideal cardiovascular health metrics and depression in Chinese population : a cross-sectional study. Nature Publishing Group (May) 1–7.
Liu, Ju-Chi, Hung, Hsiang-Lien, Shyu, Yuh-Kae, Tsai, Pei-Shan, 2011. The impact of sleep quality and daytime sleepiness on global quality of life in community-dwelling patients with heart failure. The Journal of Cardiovascular Nursing 24 (2), 99–105.
Lloyd-Jones, Donald M., Hong, Yuling, Labarthe, Darwin, Mozaffarian, Dariush, Appel, Lawrence J., Horn, Linda Van, Greenlund, Kurt, Daniels, Stephen, Nichol, Graham, Tomaselli, Gordon F., Arnett, Donna K., Fonarow, Gregg C., Michael Ho, P., Lauer, Michael S., Masoudi, Frederick A., Robertson, Rose Marie, Roger, Véronique, Schwamm, Lee H., Sorlie, Paul, Yancy, Clyde W., Rosamond, Wayne D., 2010. Defining and setting national goals for cardiovascular health promotion and disease reduction: the American Heart Association's strategic impact goal through 2020 and beyond. Circulation 121 (4), 586–613.
Marques, Daniel Ruivo, Meia-Via, Ana Maria Soares, da Silva, Carlos Fernandes, Gomes, Ana Allen, 2017. Associations between sleep quality and domains of quality of life in a non-clinical sample: results from higher education students. Sleep Health 3 (5), 348–356.
Mendis, Shanthi, Davis, Stephen, Norrving, Bo, 2015. Organizational update: the World Health Organization global status report on noncommunicable diseases 2014; one more landmark step in the combat against stroke and vascular disease. Stroke 46 (5), e121–e122.
Mielck, Andreas, Reitmeir, Peter, Vogelmann, Martin, Leidl, Reiner, 2011. Impact of educational level on health-related quality of life (HRQL): results from Germany based on the EuroQol 5D (EQ-5D). Eur. J. Pub. Health 23 (1), 45–50.
Odom, Erika C., Matthew Zack, Jing Fang, Moore, Latetia, Loustalot, Fleetwood, 2016. Associations between cardiovascular health and health-related quality of life, behavioral risk factor surveillance system, 2013. Prev. Chronic Dis. 13 (4), 160073.
Palhares, V.D.C., Corrente, J.E., Matsubara, B.B., 2014. Association between sleep quality and quality of life in nursing professionals working rotating shifts. Revista de Saude Publica 48 (4), 594–601.
Peltonen, M., Laatikainen, T., Borodulin, K., Wikström, K., 2014. Prevalence of ideal cardiovascular health in an adult Finnish population: the national FINRISK 2007 study. Int Heart Vasc Dis J 2 (3), 3–10.
Piepoli, Massimo F., Hoes, Arno W., Agewall, Stefan, Albus, Christian, Brotons, Carlos, Catapano, Alberico L., Cooney, Marie-Therese, Corrà, Ugo, Cosyns, Bernard, Deaton, Christi, Graham, Ian, Hall, Michael Stephen, Richard Hobbs, F.D., Lochen, Maja-Lisa, Löllgen, Herbert, Marques-Vidal, Pedro, Perk, Joep, Prescott, Eva, Smulders, Yvo, Tiberi, Monica, Worp, H.Bar. van der, Dis, Ineke van, Monique Verschuren, W.M., 2016. 2016 European guidelines on cardiovascular disease prevention in clinical practice the sixth joint task force of the European Society of Cardiology. Eur. Heart J. 37, 2315–2381.
Power, Mick, 2003. Development of a common instrument for quality of life. EUROHIS: Developing Common Instruments for Health Surveys 57, 145–159.
Schmidt, Silke, Mühlan, Holger, Power, Mick, 2006. The EUROHIS-QOL 8-item index: psychometric results of a cross-cultural field study. Eur. J. Pub. Health 16 (4), 420–428.
Selvin, Elizabeth, Crainiceanu, Ciprian M., Brancati, Frederick L., Coresh, Josef, 2007. Short-term variability in measures of glycemia and implications for the classification of diabetes. Arch. Intern. Med. 167 (14), 1545–1551.
THE WHOQOL GROUP, 1998. Development of the World Health Organization WHOQOL-BREF Quality of Life Assessment. The WHOQOL Group. Psychol. Med. 28, 551–558.
Tuunanen, Mervi, Aalto, Mauri, Seppä, Kaija, 2007. Binge drinking and its detection among middle-aged men using AUDIT, AUDIT-C and AUDIT-3. Drug and Alcohol Review 26 (3), 295–299.
VanKim, Nicole A., Nelson, Toben F., 2013. Vigorous physical activity, mental health, perceived stress, and socializing among college students. Am. J. Health Promot. 28 (1), 7–15.
Veromaa, Veera, Kautiainen, Hannu, Saxen, Ulla, Malmberg-Ceder, Kirsi, Bergman, Elina, Korhonen, Päivi E., 2017. Ideal cardiovascular health and psychosocial risk factors among Finnish female municipal workers. Scandinavian Journal of Public Health 45 (1), 50–56.
WHOQOL Group, 1998. The World Health Organization quality of life assessment (Whoqol): development and general psychometric properties* the Whoqol group. Soc. Sci. Med. 46 (12), 1569–1585.
Willis, Benjamin L., DeFina, Laura F., Bachmann, Justin M., Franzini, Luisa, Shay, Christina M., Gao, Ang, Leonard, David, Berry, Jarett D., 2015. Association of Ideal Cardiovascular Health and Long-Term Healthcare Costs. Am. J. Prev. Med. 49 (5), 678–685.
World Health Organization, 2013. Global Action Plan for the Prevention and Control of Noncommunicable Diseases 2013–2020. vol. 102 World Health Organization.
Yang, Quanhe, Cogswell, Mary E., Flanders, W. Dana, Hong, Yuling, Zhang, Zefeng, Loustalot, Fleetwood, Gillespie, Cathleen, Merritt, Robert, Hu, Frank B., 2012. Trends in cardiovascular health metrics and associations with all-cause and CVD mortality among US adults. Jama 307 (12), 1273.