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Metabolic syndrome is associated with impaired health-related quality of life: Lapinlahti 2005 study

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Abstract

Purpose Association of Metabolic Syndrome (MetS) with Health-Related Quality of Life (HRQoL) is poorly documented. Our objective was to examine this association in an adult general population.

Methods In our cross-sectional community-based health survey in a semirural Finnish community, we invited all the adults ($n = 760$) of eight birth cohorts between 30 and 65 years, of which 480 (63%) participated. A 15-dimensional, standardized HRQoL instrument (15D) was used to measure the main outcome, and the National Cholesterol Education Programme (NCEP) 2005 criteria were used for MetS classification.

Results The prevalence of MetS was 38%. MetS was significantly associated with impaired HRQoL ($P < 0.001$) measured by the 15D score. Participants with MetS were statistically significantly worse off than participants without MetS in the dimensions of mobility ($P < 0.001$), hearing ($P = 0.021$), breathing ($P < 0.001$), usual activities ($P = 0.001$), discomfort and symptoms ($P = 0.002$), vitality ($P = 0.003$), and sexual activity ($P = 0.008$). In a logistic regression analysis, a significant association persisted between MetS and impaired HRQoL (OR = 1.9).

Conclusions MetS seems to be associated closely with perceived HRQoL at community level. Therefore, reduction of risk factors of MetS may improve HRQoL.

Keywords 15D · Adult population · Health-related quality of life · Metabolic syndrome · Perceived health

Abbreviations

15D	15-Dimensional instrument for measuring health-related quality of life
BMI	Body mass index
DEHKO	Development programme for the prevention and care of diabetes in Finland
HRQoL	Health-related quality of life
IDF	International Diabetes Federation
LRA	Logistic regression analysis
MetS	Metabolic syndrome
MID	Minimal clinically important difference
NCEP	National Cholesterol Education Programme

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Introduction

The pathogenesis of metabolic syndrome (MetS) is complex and incompletely understood, but the interaction between obesity, a sedentary lifestyle, and dietary as well as genetic factors is known to contribute to its development [1, 2]. The syndrome is associated with an increased risk of both type 2 diabetes mellitus (five to ninefold) and cardiovascular diseases [3, 4]. It increases cardiovascular mortality two to threefold [5].

Although MetS is being studied quite extensively, evidence about its association with health-related quality of life (HRQoL) at the general population level is scarce. According to a study done in the US, however, MetS worsened intermittent claudication, physical function, HRQoL, and peripheral circulation in patients with peripheral arterial disease [6]. MetS and obesity may also be risk factors of sexual dysfunction in both sexes [7]. Moreover, there are also several reports on the association between single and multiple cardiovascular risk factors and HRQoL. In a follow-up population study, adjusted scores for physical, mental, and social functioning were best for individuals with a low risk of cardiovascular diseases, and the scores worsened significantly with the number of risk factors [8].

There is evidence from various countries that obesity is associated with impaired HRQoL, and especially physical functions, in both genders [9–13]. Furthermore, in European studies, hypertension had a clear association with impaired physical functioning, general health, vitality, and mental health [14, 15], but the association between low HRQoL and dyslipidaemia is more controversial [16, 17]. Although there is much evidence for the co-occurrence of diabetic hyperglycaemia with impaired HRQoL [18], the association between HRQoL and blood glucose level in non-diabetic general populations is poorly documented. In a Hertfordshire Cohort community-based study, however, insulin resistance was associated with impaired vitality, poor physical (but not mental) functioning, and poor general health in an elderly population [19].

Impact of MetS on general health and HRQoL deserves attention. Our aim was to assess the association between MetS and HRQoL in a general adult population in a semi-rural community.

Methods

Study population and procedure

The Lapinlahti 2005 study at the University of Kuopio, Finland, involved all 760 adult Lapinlahti residents in eastern Finland (10% of the total population of 7,513) who were born in 1939, 1944, 1949, 1954, 1959, 1964, 1969 and 1974. Altogether, 594 (78%) of them responded satisfactorily to a postal questionnaire, and 480 (63%) [230 men (59%) and 250 women (68%)] underwent a complete health survey that consisted of a structured questionnaire and a health examination. Among all participants, the participation rate was better for the participants aged 50 years or more (69%) than for the participants less than 50 years of age (57%). It was also better for women than for men in all age groups except for those born in 1944 (74% for men and 68% for women) (Table 1).

All 480 study participants filled out a structured questionnaire including background variables (age, gender, marital status, vocational education, employment status,

Table 1 Lapinlahti 2005 study: Subjects in the original study sample, respondents of the health survey and study subjects included in the complete health survey

Year of birth	Original sample ($n = 760$)		Respondents of the questionnaire survey ($n = 594$)				Participants in the complete health survey ($n = 480$)			
	Men	Women	Men		Women		Men		Women	
	n	*n*	*n*	% of original sample	*n*	% of original sample	*n*	% of original sample	*n*	% of original sample
1939	32	41	25	78.1	37	90.2	23	71.9	33	80.5
1944	38	34	35	92.1	27	79.4	28	73.7	23	67.6
1949	82	69	68	82.9	60	87.0	55	67.1	51	73.9
1954	64	57	43	67.2	47	82.5	32	50.0	41	71.9
1959	48	50	35	72.9	40	80.0	28	58.3	32	64.0
1964	49	45	37	75.5	34	75.6	27	55.1	28	62.2
1969	41	43	27	65.9	31	72.1	22	53.7	27	63.0
1974	39	28	25	64.1	23	82.1	15	38.5	15	53.6
Total	393	367	295	75.1	299	81.5	230	58.5	250	68.1

and life-style variables). The questionnaire also included the 15D questionnaire that measures HRQoL [20].

The 15D instrument is a 15-dimensional, standardized, self-administered measure of HRQoL that can be used both as a profile and as a single index score measure. The 15 dimensions are: mobility, vision, hearing, breathing, eating, speech, elimination, usual activities, mental function, discomfort and symptoms, depression, distress, vitality, and sexual activity. For each dimension, the respondent chooses one of five levels (ranked from one to five) that best describes his/her state of health at the moment. The valuation system of the 15D instrument is based on an application of the multi-attribute utility theory. A set of utility or preference weights, elicited from the general public through a 3-stage valuation procedure, is used first to generate level values for each dimension on a 0–1 scale (1 = no problem; 0 = being dead) and then to aggregate them additively into an overall HRQoL score, i.e., a 15D score (a single index number) over all the dimensions on a scale of 0–1 (1 = no problem; 0 = being dead). The minimal clinically important difference (MID) in the overall score is 0.03 [21]. The instrument has been shown to be highly reliable, sensitive and responsive to change. It is applicable at least in Western-type societies [20]. In our study, we divided the sample into tertiles and analyzed the associations of MetS and other selected variables with the highest 15D tertile versus the two lowest 15D tertiles. The alpha reliability coefficient of the 15D questionnaire in this sample was 0.850.

The HRQoL of the sample in terms of the 15D profile and score was compared with those of the general Finnish population standardized for the age and gender distribution of the sample. The HRQoL data of the general population came from the Health 2000 Health Examination Survey [22].

We used the NCEP 2005 criteria for MetS definition [23]. In a population study in the US, the NCEP 2005 definition gave an unadjusted MetS prevalence of 34% among men and 35% among women, and led to slightly lower estimates of prevalence in all demographic groups than did the IDF 2005 criteria with the same population (40% among men and 38% among women). However, the two definitions similarly classified 93% of the participants as having or not having MetS [24]. The prevalence figures in the US are rather close to those found in a Finnish population study [25].

MetS was defined from anthropometric measurements and blood test results. The presence of at least three of the five NCEP 2005 MetS criteria classified the participant as having MetS. The criteria are as follows: (1) fasting plasma glucose level ≥5.6 mmol/l and/or diabetes medication or previously diagnosed adult type diabetes, (2) serum triglyceride level ≥1.7 mmol/l and/or medication, (3) serum HDL cholesterol level <1.0 mmol/l in men and <1.3 mmol/l in women and/or medication, (4) systolic blood pressure ≥130 mmHg and/or diastolic blood pressure ≥85 mmHg and/or antihypertensive medication, and (5) waist girth >102 cm for men and >88 cm for women.

Weight was taken in light clothing (Seca standing scale) to the nearest 0.1 kg, and height was measured in a standing position to the nearest 1.0 cm. Body mass index (BMI) was calculated from the formula: weight/height^2. Waist girth was measured at the midpoint between the lowest rib and the iliac crest, and blood pressure was taken in a sitting position at 5-min intervals after 10 min of rest. For the blood pressure measurements, we used a calibrated Omron M4-1 semi-automatic device and a mercury sphygmomanometer in situations where manual measurement was the only reliable recording method. For the statistical analysis, we calculated the means of the three measurements. Glucose level was tested from capillary blood with a glucometer calibrated for plasma glucose level, and other laboratory tests were done from the serum of a venous blood sample after 12 h of fasting. All the laboratory investigations were performed according to the routine protocol of the Kuopio University Hospital's medical laboratory.

Statistical analysis

We used SPSS 14.0 for Windows statistical software (SPSS, Chicago, IL). In the statistical analysis, we regarded a P-value of less than 0.05 as statistically significant.

As the total scores and the scores of all the 15D dimensions of the study participants without and with MetS were not normally distributed, we compared them with a non-parametric Mann Whitney U test. Similarly, the whole study sample was compared with the age- and gender-standardized Finnish population sample.

With a χ^2-test we compared the prevalence of MetS, its single components and BMI ≥ 30 kg/m^2 between the three 15D total score tertiles. The score range was from 0.4512 to 0.9056 for the lowest tertile, from 0.9057 to 0.9626 for the middle tertile, and from 0.9627 to 1.0000 for the highest tertile.

Next, with a stepwise backward multiple logistic regression analysis (LRA) of the highest versus two lowest 15D tertiles, we studied associations between HRQoL and MetS status (absent vs. present) adjusted for the following seven background variables: age (continuous variable), gender (men vs. women), marital status (married or cohabiting vs. single, divorced, or widowed), vocational education (higher vocational education or university degree vs. lower vocational education or less), employment status (employed vs. unemployed or retired), smoking (non-smoker vs. smoker), and physical activity (>2 units weekly vs. ≤2 times weekly, where one unit equals to minimum of

30 min of physical exercise at work or during leisure time). The covariates with the highest *P*-value were excluded one by one. In this way, stepwise LRA was continued until the most parsimonious model that still explained the data was found at a *P*-value level less than 0.05.

Ethical approval

The Ethics Committee of Kuopio University Hospital and the University of Kuopio approved the study. All the study participants gave written informed consent.

Table 2 Lapinlahti 2005 study: Basic characteristics of the 480 study subjects

	All ($n = 480$)	MetS absent ($n = 299$; 62%)[a]	MetS present ($n = 181$; 38%)[a]
Age in years[b]	50.4 (10.2)	48.6 (10.1)	53.2 (9.8)
Proportion of males in %[c]	48	47	50
Marital status (% single, divorced or widowed)[d]	18	16	21
Vocational education (% lower education or less)[e]	70	66	76
Employment (% unemployed or retired)[f]	30	27	35
Current smoking (% smokers)[g]	28	28	29
Current alcohol use (% alcohol users)[h]	79	78	80
Current physical activity (% inactive)[i]	49	43	58
Current dietary vegetable intake (% low intake)[j]	45	40	53
Medication for depression (%)[k]	3	2	4
Diabetes medication (%[l])	4	2	8
Hypertension medication (%)[m]	22	10	40
Dyslipidaemia medication (%)[n]	14	9	22
Body mass index BMI (kg/m^2)[c]	27.8 (5.13)	25.3 (3.37)	31.8 (4.91)
Waist girth among men in cm[c]	98.5 (11.92)	92.4 (7.99)	107.9 (10.89)
Waist girth among women in cm[c]	85.1 (13.77)	77.5 (7.97)	97.7 (12.05)
Systolic blood pressure in mmHg[c]	139.2 (18.7)	135.1 (17.93)	145.8 (18.51)
Diastolic blood pressure in mmHg[c]	82.9 (10.7)	80.7 (10.04)	86.5 (10.68)
Fasting plasma glucose in mmol/l[c]	5.57 (1.16)	5.28 (0.96)	6.05 (1.29)
Serum HDL cholesterol among men in mmol/l[c]	1.09 (0.34)	1.22 (0.32)	0.89 (0.27)
Serum HDL cholesterol among women in mmol/l[c]	1.37 (0.43)	1.54 (0.40)	1.09 (0.31)
Serum triglycerides in mmol/l[c]	1.36(0.82)	1.04 (0.40)	1.90 (1.02)
Overall 15D score[o]	0.92 (0.08)	0.93 (0.07)	0.90 (0.09)

Statistical tests used: independent samples *t*-test; chi-square test

[a] Metabolic syndrome (MetS): NCEP 2005 criteria [22]

[b] Values given as means (SD) ($P < 0.001$ for all referred variables)

[c] Proportion of males given in percentages (%) of all ($\chi^2 = 0.38$; $df = 1$; $P = 0.572$)

[d] Marital status: married or cohabiting vs. single, divorced, or widowed ($\chi^2 = 1.325$; $df = 1$; $P = 0.270$)

[e] Vocational education: higher vocational education or university degree vs. lower vocational education or less ($\chi^2 = 5.502$; $df = 1$; $P = 0.024$)

[f] Employment: employed vs. unemployed or retired ($\chi^2 = 3.367$; $df = 1$; $P = 0.075$)

[g] Current smoking: non-smoker vs. smoker ($\chi^2 = 0.034$; $df = 1$; $P = 0.916$)

[h] Current alcohol use: no vs. yes ($\chi^2 = 0.178$; $df = 1$; $P = 0.731$)

[i] Current physical activity: active (3 units or more/week) vs. inactive (0–2 units/week); one unit = minimum of 30 min of physical exercise at work or during leisure time) ($\chi^2 = 9.959$; $df = 1$; $P = 0.002$)

[j] Current dietary vegetable intake: high = on 3 or more days weekly vs. low = on 0–2 days weekly ($\chi^2 = 7.818$; $df = 1$; $P = 0.006$)

[k] No vs. yes ($\chi^2 = 1.481$; $df = 1$; $P = 0.253$)

[l] No vs. yes ($\chi^2 = 10.631$; $df = 1$; $P = 0.002$)

[m] No vs. yes ($\chi^2 = 59.643$; $df = 1$; $P < 0.001$)

[n] No vs. yes ($\chi^2 = 15.905$; $df = 1$; $P < 0.001$)

[o] 15D: 15D instrument for health-related quality of life (15 dimensions) [20, 21] ($P < 0.001$; 95% CI 0.0131–0.0425)

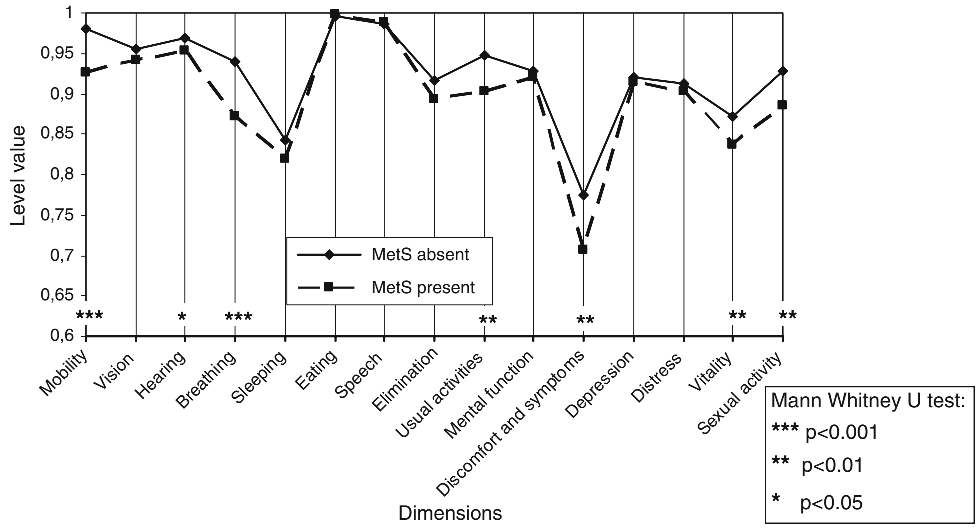

Fig. 1 Lapinlahti 2005 study: 15D profiles by metabolic syndrome (MetS) status based on the National Cholesterol Education Programme (NCEP 2005 [22]) criteria for MetS ($n = 480$)

Results

The basic characteristics of the participants are presented in Table 2. The proportion of women was 52% and the mean age of all was 50.4 (SD 10.2) years. The mean age of the participants with MetS was 4.5 years higher than that of the participants without MetS ($P < 0.001$).

The prevalence of MetS in the whole sample was 38% (39% among men and 36% among women). Of all the study participants, 11% had no MetS components, while 27% had one and 62% had two or more MetS components. The prevalence of the positive single MetS components was 74% for blood pressure, 44% for serum HDL cholesterol, 42% for fasting plasma glucose, 33% for waist girth, and 25% for serum triglyceride.

Figure 1 presents the 15D profiles by MetS status. The 15D total score was statistically significantly lower in the participants with MetS than in those without MetS ($P < 0.001$). The participants with MetS were statistically significantly worse off than those without MetS in the dimensions of mobility ($P < 0.001$), hearing ($P = 0.021$), breathing ($P < 0.001$), usual activities ($P = 0.001$), discomfort and symptoms ($P = 0.002$), vitality ($P = 0.003$), and sexual activity ($P = 0.008$). The 15D profile of our sample did not significantly differ from that of the age- and gender-standardized Finnish population (data not shown).

Table 3 indicates the prevalences of MetS, its positive components and BMI ≥ 30 kg/m^2 in the 15D tertile groups. MetS prevalence was significantly lower in the highest 15D tertile (27%) than in the lowest and the middle 15D tertiles (47% and 39%, respectively), with a significant difference between the groups ($P = 0.001$). Similarly, the prevalence of elevated waist girth increased from 20% in the highest to 45% in the lowest 15D tertile ($P < 0.001$). The same trend was seen in BMI ($P = 0.009$) and blood pressure ($P = 0.036$). On the other hand, a high prevalence of elevated fasting plasma glucose level clustered in the two lowest 15D tertiles, with a significant difference in prevalence between the highest 15D tertile and the rest ($P = 0.039$). The difference in the prevalence of elevated triglyceride and low HDL cholesterol between the three groups was statistically insignificant.

In the multivariate stepwise backward logistic regression analysis (Table 4), MetS was significantly associated with impaired HRQoL (OR = 1.9). Similarly, impaired HRQoL was significantly more common in women (OR = 1.6), in participants with lower vocational education (OR = 2.3), and in unemployed or retired participants (OR = 1.8), while no significant association of HRQoL

Table 3 Lapinlahti 2005 study: prevalence of metabolic syndrome (MetS), its positive components and body mass index (BMI) ≥ 30 by 15D tertiles ($n = 480$)

	15D tertiles			*P*-value
	Lowest %	Middle %	Highest %	
MetS	47	39	27	0.001
Waist girth[a]	45	34	20	<0.001
Fasting plasma glucose[b]	47	45	34	0.039
Serum HDL cholesterol[c]	48	47	39	0.177
Serum triglyceride[d]	26	27	21	0.437
Blood pressure[e]	80	74	68	0.036
BMI ≥ 30 kg/m^2	37	27	22	0.009

Statistical test used: chi-square test

[a] >102 cm in men or >88 cm in women

[b] ≥5.6 mmol/l, or previously diagnosed type 2 diabetes, and/or medication

[c] <1.0 mmol/l in men or <1.3 mmol/l in women, and/or medication

[d] ≥1.7 mmol/l, and/or medication

[e] Systolic BP ≥ 130 mmHg or diastolic BP ≥ 85 mmHg, and/or medication

Table 4 Lapinlahti 2005 study: statistically significant associations in multivariate logistic backward regression analysis. Odds ratios for low HRQoL measured by the 15D instrument

Variable	Included in analysis (*n*)	OR (95% CI)	*P*-value
Gender			
Male	226	1	
Female	237	1.649 (1.082;2.513)	0.020
Vocational education			
Higher	140	1	
Lower	323	2.346 (1.499;3.673)	<0.001
Employment status			
Employed	326	1	
Unemployed/retired	137	1.794 (1.104;2.914)	0.018
MetS			
Absent	288	1	
Present	175	1.868 (1.208;2.887)	0.005

Statistical test used: multivariate backward stepwise logistic regression analysis

The following variables were entered into the model: age, continuous variable ($P > 0.05$); gender, men vs. women; marital status, married or cohabiting vs. single, divorced, or widowed ($P > 0.05$); vocational education, higher vocational education or university degree vs. lower vocational education or less; employment status, employed vs. unemployed or retired; smoking, non-smoker vs. smoker ($P > 0.05$); physical activity, >2 units weekly vs. ≤2 units weekly (one unit equals to minimum of 30 min of physical exercise at work or during leisure time) ($P > 0.05$); MetS-status, absent vs. present (NCEP 2005 criteria [22])

was found with marital status, age, smoking or physical activity.

Discussion

Our main finding was that MetS was associated with impaired HRQoL. Using the 15D instrument, participants with MetS were worse off than those without MetS in the dimensions of mobility, hearing, breathing, usual activities, discomfort and symptoms, vitality and sexual activity. Impaired HRQoL was associated with a low vocational education level and non-working. Men had significantly better HRQoL than women. Furthermore, the prevalence of MetS was fairly high in this adult population; more than a third of the study participants had MetS using the NCEP 2005 criteria for MetS.

Strengths and limitations of the study

To our knowledge, this is the first comprehensive report on the association between MetS and HRQoL in the general adult population. The main strengths of this study are its wide coverage of a single community and its comprehensive assessment of MetS. Due to the fairly high rate of participation, the study population represents the adult population of the community, which is a typical semi-rural community in eastern Finland. The age and gender profiles of the respondents differed slightly from that of the non-respondents. However, the results may apply at least to other Finnish communities with a similar demographic pattern.

After testing the NCEP 2005 and IDF 2005 criteria for MetS, we preferred the NCEP 2005 criteria which have been validated in the Finnish population [3] and shown to predict cardiovascular and overall mortality [5]. The 15D instrument detects various dimensions of HRQoL, i.e., mental and physical. It is documented as a reliable instrument for scientific use, and is well applicable at least to Western societies. An obvious limitation of the study is its cross-sectional nature, and therefore the question of the time-courses of Mets and HRQoL remains unclarified.

Comparison with existing literature

There are no previous comprehensive reports about the association between MetS and HRQoL at the population level. In the Hertfordshire Cohort study, however, insulin resistance was associated with impaired vitality, poor physical functioning, and poor general health in the elderly population [19]. On the other hand, our results support earlier findings on the association of specific metabolic parameters with HRQoL [8]. The association between obesity and HRQoL has been documented in several studies, which is consistent with our finding that elevated waist girth is also closely related to impaired HRQoL.

Mobility and breathing difficulties, which were associated with MetS in our study, are obviously related to and most likely caused by obesity. However, MetS has also been reported as a distinct risk factor of a decline of mobility in the elderly population [26]. Furthermore, a Finnish study has documented that obesity impairs cardiorespiratory performance, and low maximal oxygen uptake behaves as an independent MetS characteristic [27]. This finding justifies the hypothesis that perceived respiratory problems are obesity-related. Further, participants with MetS experienced hearing difficulties, which are not usually considered hallmarks of MetS and diabetes. Although this can be an accidental finding and a matter of criticism, it is also possible that hearing problems may be due to vascular dysfunction related to obesity and other cardiovascular risk factors [28]. Another possibility is that hearing difficulties reflect past noise exposure reflecting the background variables, such as socioeconomic status as manual workers working in less protected environments.

The association between MetS and discomfort and symptoms, which was analyzed in our study, has not been reported earlier, yet there are some reports about the association of MetS and chronic pain: young adult and middle-aged women with fibromyalgia had an almost six-fold higher risk of MetS than demographically similar women without chronic pain [29]. It is worth noting, though, that the 15D dimension of discomfort and symptoms primarily measures the experience of pain, so in this light our finding is in line with earlier findings. A very attractive hypothesis arises that pro-inflammation, which is caused by a visceral adipose tissue reaction, could play a key role in the origin of chronic pain (and discomfort) in MetS participants. Furthermore, there is increasing evidence that pre-inflammatory cytokines, which are activated in pain reactions, are also involved in the pathogenesis of MetS and a variety of other chronic conditions [30].

It is rather difficult to explain the mechanisms behind impaired performance of usual activities and decreased vitality in MetS. Obesity-related sleepiness could be one cause of fatigue, which is an essential element of impaired vitality. Possible mediating mechanisms are most likely multifactorial and vary inter-individually. These mechanisms can be related to abdominal obesity and associated sleep disturbances, with consequent daytime sleepiness and fatigue, or they can be a part of complex neuroendocrine dysregulation [31].

Obesity has been documented to be a risk factor of sexual dysfunction in both sexes, but the data for MetS are preliminary [7, 32]. MetS in men is associated with erectile dysfunction [33] as well as a lowered testosterone level, which is reversible after weight loss [34]. Low testosterone levels in men are known to contribute to a loss of libido, and therefore prevention of MetS can also be considered important for male sexual health. Likewise, an abnormal sex steroid profile characterizes women with MetS at the population level [35].

Implications for future research and clinical practice

While MetS and HRQoL are closely associated, we cannot say whether Mets leads to decreased HRQoL. Further prospective studies should be able to assess this time-course.

However, the high prevalence of MetS and its close association with HRQoL may justify targeted health promotion and life style changes in communities.

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