Abdominal obesity and hypertension are correlated with health-related quality of life in Taiwanese adults with metabolic syndrome

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ABSTRACT

Objective Metabolic syndrome (MetS) gains more attention due to high prevalence of obesity, diabetes and hypertension among adults. Although obesity, diabetes and hypertension can certainly compromise health-related quality of life (HRQoL), the correlations of sociodemographic factors, quality of life and MetS remains unclear. This study aims to investigate the association between HRQoL and MetS in an Asian community of the sociodemographic characteristics.

Research design and methods We performed a cross-sectional study by recruiting 2588 Taiwanese patients aged ≥30 years between August 2015 and August 2017. Sociodemographic data and anthropometric variables were obtained from medical records and physical examination. Meanwhile, HRQoL was assessed by 36-item Short-Form Health Survey questionnaires.

Results The overall prevalence of MetS was 32.8%. Multivariate analysis revealed that age ≥65 years (OR=1.987, p<0.001), body mass index (BMI) ≥24 kg/m² (OR=7.958, p<0.001), low educational level (OR=1.429, p=0.014), bad self-perceived health status (OR=1.315, p=0.01), and betel nut usage (OR=1.457, p=0.048) were associated with the development of MetS. For patients with MetS, the physical and mental health domains of HRQoL are negatively correlated with abdominal obesity and hypertension, respectively.

Conclusions Adult MetS in Taiwan was associated with certain sociodemographic factors including older age, high BMI, low educational level, bad self-perceived health status, and betel nut use. Abdominal obesity and hypertension was correlated with HRQoL in patients with MetS.

INTRODUCTION

The National Cholesterol Education Program's Adult Treatment Panel III (NCEP-ATP III) defined adults who develop metabolic syndrome (MetS) as those having at least three out of the following five anomalies: abdominal obesity, high triglycerides level, low high-density lipoprotein cholesterol (HDL-C) level, hypertension and hyperglycemia. MetS is associated with cardiovascular disease (CVD) and increasingly found in the elderly in developed countries. MetS has a significant impact on morbidity and mortality on CVDs, type 2 diabetes and social-psychological illnesses. The association between MetS and impaired health-related quality of life (HRQoL) has been reported.

HRQoL, an individual's overall sense of well-being, is based on subjective physical, social and psychological functioning that are self-reported. It has become an essential outcome variable for healthcare, given for

Significance of this study

What is already known about this subject?

- Metabolic syndrome comprises the clustering of traditional cardiovascular risk factors that are highly associated with increased risk of cardiovascular disease and may trigger physical and mental problems.
- Heterogeneity across geographical regions, study population variability, and different sociodemographic factors affect the prevalence of metabolic syndrome.
- Although obesity, diabetes and hypertension can certainly compromise health-related quality of life, the correlations of sociodemographic factors, quality of life and metabolic syndrome remains unclear.
- The 36-item Short-Form Health Survey (SF-36) questionnaire is widely used for assessing health-related quality of life.
those with chronic illness. HRQoL can be measured using 36-Item Short-Form Health Survey (SF-36), one of the leading HRQoL measurements that is broadly applied in MetS research. The SF-36 survey contains the following 36 items covering functional health status and general health (GH); eight dimensions including physical functioning (PF), role physical (RP), bodily pain (BP), GH, vitality (VT), social functioning (SF), role emotional (RE), and mental health (MH) and two domains including physical component summary (PCS) and mental component summary (MCS). The higher scores, both on eight dimensions and two domains, indicate better functioning. This impaired HRQoL has a negative impact on therapy response and disease control and survival in MetS patients.

However, this association was only found in participants with female gender, depression, or high body mass index (BMI) after adjusting for the confounding factors such as sociodemographic variables, medical comorbidities, and obesity. Impaired HRQoL was associated with high BMI rather than MetS, confirmed by a study on obese participants with a BMI of over 30 kg/m². In Korea, abdominal obesity and dyslipidemia were associated with impaired HRQoL. Corica et al. also reported that obesity, hypertension, and diabetes mellitus were the main contributors to poor HRQoL. A correlation has been considered between MetS and poor HRQoL in Japan, whereas this correlation was not found in studies from Taiwan. Furthermore, whether MetS is a mere aggregation of metabolic abnormalities or a syndrome representing a clinical entity concerns, the critical investigators and the different associations of certain MetS components with HRQoL have been reported among various populations. Finally, since heterogeneous geographic area and study population variability influence the estimates of the prevalence of MetS in analyzing the association between MetS and HRQoL, MetS-related risk factors such as sociodemographic background and medical status that could be interrelated with each other should be considered. Nowadays, the association between HRQoL and MetS or MetS components remains debatable. Different patterns of MetS components in various ethnicities could result in different effects on HRQoL of individuals.

Therefore, this study aims to investigate the association between HRQoL and MetS in an Asia community under consideration of the sociodemographic characteristics.

**METHODS**

**Study design**

We conducted a cross-sectional study and enrolled residents aged over 30 years who received a health assessment program from August 2015 to August 2017 at Chang Gung Memorial Hospital (CGMH), Keelung, Taiwan. The subjects were excluded from the study if they had already been diagnosed with MetS or had one of the following medical conditions previously: major gastrointestinal disorder; autoimmune disorder; end-stage renal failure; liver cirrhosis; heart failure; diabetes mellitus; uncontrolled blood pressure; recent cardiovascular events; dementia; ongoing infection; active participation in a weight-loss program; pregnancy; and receipt of regular medications that could substantially modulate the metabolism and weight, such as steroids or megestrol acetate. We explained the research study to the participants, including the purpose, procedures, rights, and confidentiality aspects.

They completed physical examinations, laboratory tests, and questionnaires through one-on-one interviews. To assure that they had the required cognitive ability, we asked three fact-based questions including the current year, a simple addition equation, and correct day of the week after the one identified. If any of these three questions were answered incorrectly, the participants’ questionnaires were considered ineligible. From a total of 2901 participants recruited, 313 cases (28 women and 285 men) were excluded and 2588 participants (1629 women and 959 men) completed all the required study assessments, yielding a response rate of 89.2%.

**Assessment of sociodemographic variables**

Sociodemographic data, including age, gender, sex, marital status, level of educational attainment, smoking habits, alcohol, betel nut usage, and any history of obesity, diabetes, hypertension, and CVD, were collected. Participants who were employed in the construction industry including building, bridge, tunnel, railway tracks and road paving were put under the occupation category ‘Labourer’. Educational attainment was classified into the following three groups: less than 9 years (junior high school), 9–12 years (senior high school), and more than 12 years (college and above). Marital status was divided into the following two classifications: currently married and currently unmarried (including single, widowed, divorced, or separated). Smoking exposure was considered affirmative if participants were current or former smokers. Alcohol consumption was considered affirmative if participants reported consuming four drinks or more per week. Habits of betel nut usage were considered affirmative if participants indicated any usage during the previous year.
Table 1 Characteristics of the 2588 participants according to the presence of metabolic syndrome (MetS)

| Variables expressed as number (%) or mean±SD | All (n=2588) | Without MetS (n=1738) | With MetS (n=850) | P* |
|---|---|---|---|---|
| Gender | | | | 0.022 |
| Men | 959 (37.1) | 617 (35.5) | 342 (40.2) | |
| Women | 1629 (62.9) | 1121 (64.5) | 508 (59.8) | |
| Age | 55.9±12.6 | 54.8±11.8 | 59.1±11.2 | <0.001 |
| <65 years | 1992 (77.0) | 1422 (81.8) | 570 (67.1) | |
| ≥65 years | 596 (23.0) | 316 (18.2) | 280 (32.9) | |
| BMI | 24.9±12.6 | 23.6±3.0 | 27.7±3.6 | <0.001 |
| ≤24 | 1139 (44.0) | 1014 (58.3) | 125 (14.7) | |
| >24 | 1449 (56.0) | 724 (41.7) | 725 (85.3) | |
| Marital status | | | | 0.168 |
| Married | 2084 (80.5) | 1386 (79.7) | 698 (82.1) | |
| Unmarried† | 504 (19.5) | 352 (20.3) | 152 (17.9) | |
| Educational attainment (years) | | | | <0.001 |
| ≤9 years (junior high school) | 1189 (45.9) | 714 (41.1) | 475 (55.9) | |
| 9–12 years (senior high school) | 758 (29.3) | 538 (31.0) | 220 (25.9) | |
| >12 years (college and above) | 641 (24.8) | 486 (27.9) | 155 (18.2) | |
| Self-perceived health status | | | | <0.001 |
| Upper | 1272 (49.1) | 903 (52.0) | 369 (43.4) | |
| Lower | 1316 (50.9) | 835 (48.0) | 481 (56.6) | |
| Source of household income | | | | 0.002 |
| Self | 1532 (59.2) | 1070 (61.6) | 462 (54.4) | |
| Relatives | 886 (34.2) | 561 (32.3) | 325 (38.2) | |
| Government | 170 (6.6) | 107 (6.2) | 63 (7.4) | |
| Occupation | | | | 0.014 |
| Farmer/fisherman/livestock | 124 (4.8) | 73 (4.2) | 51 (6.0) | |
| Laborer | 569 (22.0) | 366 (21.1) | 203 (23.9) | |
| Government employee | 286 (11.1) | 202 (11.6) | 84 (9.9) | |
| Services | 1098 (42.4) | 767 (44.1) | 331 (38.9) | |
| None‡ | 511 (19.7) | 330 (19.0) | 181 (21.3) | |
| Diet | | | | 0.797 |
| Vegetarian | 2504 (96.8) | 1680 (96.7) | 824 (96.9) | |
| Non-vegetarian | 84 (3.2) | 58 (3.3) | 26 (3.1) | |
| Smoking | | | | 0.024 |
| Yes | 652 (25.2) | 414 (23.8) | 238 (28.0) | |
| No | 1936 (74.8) | 1324 (76.2) | 612 (72.0) | |
| Drinking | | | | 0.509 |
| Yes | 1042 (40.3) | 708 (40.7) | 334 (39.3) | |
| No | 1546 (59.7) | 1030 (59.3) | 516 (60.7) | |
| Betel nut usage | | | | 0.007 |
| Yes | 191 (7.4) | 111 (6.4) | 80 (9.4) | |
| No | 2397 (92.6) | 1627 (93.6) | 770 (90.6) | |

*P value was determined using χ² test (for gender, BMI, marital status, educational attainment, self-perceived health status, source of household income, occupation, diet, smoking, drinking, and betel nut usage).
†Unmarried included single, divorced, and widowed.
‡None included housewives.
BMI, body mass index; MetS, metabolic syndrome.
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Table 2  Health-related quality of life data assessed using 36-Item Short-Form Health Survey (SF-36) among the 2588 participants according to the presence of MetS

| Variables expressed as mean±SD | All (n=2588) | Without MetS (n=1738) | With -MetS (n=850) | P* |
|-------------------------------|-------------|-----------------------|--------------------|----|
| SF-36 subscales               |             |                       |                    |    |
| PF                            | 89.48±15.73 | 91.09±14.07           | 86.18±18.25        | <0.001|
| RP                            | 84.41±32.60 | 85.44±31.44           | 82.31±34.78        | 0.027 |
| BP                            | 81.44±20.94 | 82.17±20.73           | 79.94±21.29        | 0.011 |
| GH                            | 64.87±20.56 | 65.52±20.07           | 63.52±21.47        | 0.023 |
| VT                            | 68.62±20.33 | 68.33±20.14           | 69.21±20.73        | 0.299 |
| SF                            | 92.08±13.18 | 91.68±13.35           | 92.88±12.80        | 0.028 |
| RE                            | 87.80±29.44 | 88.15±28.83           | 87.09±30.63        | 0.393 |
| MH                            | 74.43±17.84 | 73.72±17.72           | 75.86±18.00        | 0.004 |
| PCS                           | 52.66±7.13  | 53.29±6.80            | 51.37±7.60         | <0.001|
| MCS                           | 51.43±8.87  | 50.98±8.79            | 52.35±8.96         | <0.001|

*P value was determined using independent Student’s t-test.
BP, bodily pain; GH, general health; MCS, mental component summary; MetS, metabolic syndrome; MH, mental health; PCS, physical component summary; PF, physical functioning; RE, role emotional; RP, role physical; SF, social functioning; VT, vitality.

Assessment of anthropometric variables
Anthropometric data, including blood pressure, weight, height, BMI, and waist circumference (WC), were recorded for each participant. Body height and weight were measured by an automatic height–weight scale to the nearest 0.1 cm and 0.1 kg, respectively. Systolic and diastolic blood pressure was measured twice, after 5 min rest, using validated and calibrated electronic sphygmomanometers. The BMI was calculated from the height and body weight of each participant (weight in kilograms divided by the square of the height in meters, kg/m²). WC was used to examine central adiposity and measured to the nearest 0.1 cm at the midpoint between the 12th rib and right anterior superior iliac spine, using an unstretched tape meter. All data were collected consistently by the two qualified researchers who had been trained by a certified International Society for the Advancement of Kinanthropometry specialists before this study, in order to collect data in a standardized way.

Diagnostic criteria for MetS
MetS was defined according to the modified NCEP-ATP III as the presence of three or more of the following conditions: (1) hypertension: systolic blood pressure ≥130 mm Hg or diastolic blood pressure ≥85 mm Hg, or the use of antihypertensive agents; (2) hyperglycemia: fasting blood glucose level ≥100 mg/dL; (3) low serum HDL-C: ≤40 mg/dL for men or ≤50 mg/dL for women; (4) hypertriglyceridemia: triglyceride (TG) level ≥150 mg/dL; and (5) abdominal obesity: WC ≥90 cm for men and ≥80 cm for women.³

Assessment of HRQoL
HRQoL was measured using the SF-36 questionnaire.²⁶ The SF-36 scores were summarized using two widely accepted domains, PCS and MCS, based on exploratory factor analysis of the eight SF-36 subscales related to physical health (PF, RP, BP, and GH) and related to mental well-being (VT, SF, RE, and MH). The higher scores with 0–100 range indicated better health.¹⁰

Expert validation and data collection
A structured questionnaire and direct objective measures were used to collect data, including demographic data, anthropometric data, and HRQoL. We invited six experts, including two cardiologists, one endocrinologist, one family medicine physician, and two senior nursing practitioners, all of whom had practiced for over 10 years, in order to ensure the integrity, suitability, and diction of questionnaires. They conducted a content validity test, in which the content validity index was 0.90. The questionnaires were also analyzed for internal reliability using a Cronbach’s α coefficient by 10 senior nurses with more than 3 years of working experience at internal medicine wards. The Cronbach’s α coefficient was 0.85, indicating good reliability.

Under the guidance of the study nurses who were specially trained by our seven experts, each participants took approximately 30–35 min to complete and provide their medical records, including details about their current medications. Physical examinations included gathering the data of their body height, body weight, WC, and blood pressure. Blood samples were collected after overnight fasting. The biochemical data included levels of fasting glucose, glycated hemoglobin (HbA1C), TG, total cholesterol, HDL-C, low-density lipoprotein cholesterol (LDL-C), C reactive protein (CRP), and insulin resistance were measured by homeostasis model assessment-insulin resistance using an autoanalyzer (Beckman, USA) in the CGMH central laboratory in Keelung.
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Table 3

Logistic regression analysis of risk factors for metabolic syndrome among the 2588 participants in the entire study

| Variables                          | OR    | 95% CI            | P*    |
|------------------------------------|-------|-------------------|-------|
| Age (ref: <65 years)               | 1.987 | 1.555 to 2.539    | <0.001*|
| Gender (ref: female)               | 0.941 | 0.720 to 1.229    | 0.653 |
| BMI (ref: <24 kg/m²)               | 7.958 | 6.394 to 9.905    | <0.001*|
| Educational attainment (ref: college and above) |       |                   |       |
| ≤9 years (junior high school)      | 1.429 | 1.076 to 1.879    | 0.014*|
| 9–12 years (senior high school)    | 1.234 | 0.935 to 1.629    | 0.138 |
| Self-perceived health status (ref: good) | 1.315 | 1.068 to 1.620    | 0.010*|
| Source of household income (ref: self) |       |                   |       |
| Relatives                          | 1.149 | 0.906 to 1.456    | 0.251 |
| Government                         | 0.932 | 0.630 to 1.381    | 0.726 |
| Occupation (ref: none†)            |       |                   |       |
| Farmer/fisherman/livestock         | 1.259 | 0.803 to 1.974    | 0.316 |
| Laborer                            | 1.494 | 0.887 to 2.516    | 0.131 |
| Government employee                | 1.271 | 0.787 to 2.054    | 0.327 |
| Services                           | 1.191 | 0.765 to 1.856    | 0.439 |
| Smoking (ref: no)                  | 1.102 | 0.844 to 1.438    | 0.474 |
| Betel quid use (ref: no)           | 1.457 | 1.003 to 2.118    | 0.048*|
| MCS‡                               | 0.988 | 0.974 to 1.002    | 0.102 |
| PCS§                               | 1.009 | 0.998 to 1.021    | 0.102 |

*P value <0.05.
†None included housewives.
BMI, body mass index; MCS, mental component summary; PCS, physical component summary.

RESULTS

Demographic features of MetS

Table 1 shows the different demographic characteristics among participants with and without MetS. Among the participants, the prevalence of MetS was 32.8% (850/2,588), and the average age was 55.9±12.6 years. Most participants were women (62.9%) and married (80.5%). More than half of the participants (54.1%) had graduated from senior high school. The mean BMI was 24.9 kg/m² (95% CI 15.0 to 51.0), and there was significant BMI differences between genders with 25.6 kg/m² (95% CI 16.8 to 39.4) in men and with 24.3 kg/m² (95% CI 15.2 to 40.0) in women. As compared with non-MetS, a greater proportion of participants with MetS were found in the following subgroups: male gender (40.2% vs 35.5%, p=0.022), age ≥65 years (32.9% vs 18.2%, p<0.001), BMI >24 kg/m² (85.3% vs 41.7%, p<0.001), lower educational level (81.8% vs 72.1% at below college level, p<0.001), lower self-perceived health status (55.6% vs 48.0%, p<0.001), non-self household income (45.6% vs 38.5%, p=0.002), unemployed status (21.3% vs 19.0%, p=0.014), more smoking exposure (28.0% vs 23.8%, p=0.024), and betel nut usage (9.4% vs 6.4%, p=0.007).

MetS clinical features of participants

Participants with MetS demonstrated significantly higher values of body weight (70.3±12.4 kg vs 60.0±10.2 kg), WC (89.0±8.5 cm vs 77.8±7.4 cm), BMI (27.7±3.6 kg/m² vs 23.6±3.0 kg/m²), systolic blood pressure (139.6±16.3 mm Hg vs 125.8±17.1 mm Hg), diastolic blood pressure (82.7±10.7 mm Hg vs 75.9±10.4 mm Hg), fasting glucose levels (118.3±35.8 mg/dL vs 96.2±15.2 mg/dL), HbA1C level (6.3%±1.1% vs 5.6%±0.9%), total cholesterol level (212.5±53.9 mg/dL vs 204.8±36.8 mg/dL), TG level...
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### Table 4  Multivariate associations between physical component summary (PCS) and mental component summary (MCS) among the 850 participants with MetS

| Variable                                             | Coefficient | 95% CI            | P*  |
|------------------------------------------------------|-------------|-------------------|-----|
| **PCS**                                              |             |                   |     |
| Sex (ref: female)                                    | 0.436       | −1.023 to 1.895   | 0.557|
| Age (ref: <65 years)                                 | −2.762      | −3.913 to 1.611   | 0.000*|
| BMI (ref: <24 kg/m²)                                 | 0.162       | −1.359 to 1.683   | 0.835|
| Self-perceived health status (ref: good)             | −4.518      | −5.490 to 3.545   | 0.000*|
| Educational attainment (ref: college and above)       |             |                   |     |
| ≤9 years (junior high school)                        | −2.036      | −3.608 to 0.463   | 0.011*|
| 9–12 years (senior high school)                      | −1.387      | −2.931 to 0.157   | 0.078|
| Source of household income (ref: self)                |             |                   |     |
| Relatives                                            | −0.235      | −1.437 to 0.968   | 0.702|
| Government                                           | 0.411       | −1.501 to 2.322   | 0.673|
| Occupation (ref: none*)                               |             |                   |     |
| Farmer/fisherman/livestock                           | −2.191      | −4.507 to 0.125   | 0.064|
| Worker                                               | −0.715      | −2.312 to 0.883   | 0.38 |
| Government employee                                  | −1.336      | −3.403 to 0.731   | 0.205|
| Services                                             | −0.001      | −1.392 to 1.39    | 0.999|
| Betel nut use (ref: no)                              | 0.723       | −1.142 to 2.587   | 0.447|
| Smoking (ref: no)                                    | 0.391       | −0.993 to 1.774   | 0.580|
| Abdominal obesity (ref: no)                          | −1.734      | −3.027 to 0.44    | 0.009*|
| Hypertension (ref: no)                               | −1.46       | −2.972 to 0.053   | 0.059|
| Impaired glucose tolerance (ref: no)                 | −0.252      | −1.517 to 1.012   | 0.695|
| High TG level (ref: no)                              | −0.476      | −1.588 to 0.636   | 0.401|
| Low HDL-C level (ref: no)                            | −0.8        | −1.850 to 0.250   | 0.135|
| **MCS**                                              |             |                   |     |
| Sex (ref: female)                                    | 2.509       | 0.723 to 4.295    | 0.006*|
| Age (ref: <65 years)                                 | 2.168       | 0.759 to 3.577    | 0.003*|
| BMI (ref: <24 kg/m²)                                 | −0.145      | −2.007 to 1.716   | 0.878|
| Self-perceived health status (ref: good)             | −4.409      | −5.599 to 3.118   | 0.000*|
| Educational attainment (ref: college and above)       |             |                   |     |
| <9 years (junior high school)                        | −2.361      | −0.436 to 4.285   | 0.016*|
| 9–12 years (senior high school)                      | 0.859       | −1.031 to 2.749   | 0.372|
| Source of household income (ref: self)                |             |                   |     |
| Relatives                                            | −1.979      | −3.451 to 0.057   | 0.008*|
| Government                                           | −1.362      | −3.702 to 0.978   | 0.254|
| Occupation (ref: none†)                              |             |                   |     |
| Farmer/fisherman/livestock                           | −1.249      | −4.083 to 1.586   | 0.388|
| Worker                                               | −1.186      | −3.142 to 0.770   | 0.234|
| Government employee                                  | −0.237      | −2.767 to 2.294   | 0.854|
| Services                                             | −0.044      | −1.747 to 1.659   | 0.960|
| Betel nut use (ref: no)                              | 0.141       | −2.241 to 2.424   | 0.903|
| Smoking (ref: no)                                    | −2.225      | −3.918 to 0.531   | 0.010*|
| Abdominal obesity (ref: no)                          | 1.430       | −0.154 to 3.014   | 0.077|
| Hypertension (ref: no)                               | −1.988      | −0.137 to 3.839   | 0.035*|
| Impaired glucose tolerance (ref: no)                 | −0.330      | −1.878 to 1.218   | 0.676|

Continued
Table 4 Continued

| Variable                        | Coefficient | 95% CI     | P*     |
|---------------------------------|-------------|------------|--------|
| High TG level (ref: no)         | -1.178      | -2.539 to 0.183 | 0.090  |
| Low HDL-C level (ref: no)       | -0.674      | -1.959 to 0.611  | 0.303  |

*P value <0.05.
†None included housewives.
BMI, body mass index; HDL-C, high-density lipoprotein cholesterol; TG, triglyceride.

(192.8±107.7 mg/dL vs 98.1±35.4 mg/dL), LDL-C level (127.7±30.9 mg/dL vs 120.0±28.6 mg/dL), CRP level (2.9±0.4 mg/dL vs 1.8±0.2 mg/dL), insulin resistance level (11.8±3.7 mU/L vs 6.6±1.5 mU/L) and lower values of HDL-C level (48.62±10.9 mg/dL vs 60.3±13.1 mg/dL) than those without MetS (all p<0.001). We further compared HRQoL of participants between with and without MetS group (table 2).

QoL-related factors in patients with and without MetS

The participants in the MetS group reported lower scores on PF, RP, BP, GH, and PCS, but higher scores on SF, MH, and MCS. There was no score difference between the two groups in VT and RE. The multivariate analysis using logistic regression model revealed that age ≥65 years (OR=1.987), BMI ≥24 kg/m² (OR=7.958), low educational level (OR=1.429), bad self-perceived health status (OR=1.315), and betel nut usage (OR=1.457) were positively correlated with male gender and age ≥65 but negatively correlated with lower self-perceived health status, lower educational level, and abdominal obesity; MCS scores were positively correlated with male gender and age ≥65 years but negatively correlated with lower self-perceived health status, lower educational level, household income from relatives, smoking exposure, and hypertension (table 4).

DISCUSSION

We examined the relationship between MetS and HRQoL in this study and found that MetS was not significantly related with HRQoL using SF-36 questionnaire after the adjustments of confounding factors among Asia adults. Interestingly, the PCS and MCS of HRQoL in the MetS group were associated with gender, age, self-perceived health status, educational attainment, household income, smoking exposure, abdominal obesity, and hypertension. These observations suggested that sociodemographic variables and MetS components that increased the risk of MetS development are correlated with HRQoL. Accumulative evidence has shown marked association between MetS and the worsening of HRQoL, but a growing body of studies including the current one have failed to show this association (table 5).

This discrepant observation still exists even though participants with the same ethnicity and geographic distribution were studied. The following evidence can explain this discrepancy. First, impaired HRQoL may be attributed to obesity and different patterns of MetS components, not MetS itself, thus representing some degrees of cumulative contributions from the individual components. Tsai’s group studied obese participants with a BMI of 30–50 kg/m² in a randomized weight reduction trial and found that impaired HRQoL was associated with high BMI rather than MetS since obese participants suffer more psychiatric disorders and may be disadvantaged in education, employment, and healthcare related to MetS. Two studies from the Korean population found that abdominal obesity and dyslipidemia were associated with impaired HRQoL after adjusting the sociodemographic variables, medical comorbidity, and obesity. In accordance with Jahangiry’s study, our observation that abdominal obesity and hypertension affected HRQoL in participants with MetS further supports the close association between individual MetS component and HRQoL. Second, various validated tools to quantify the influence of HRQoL were applied. HRQoL can be assessed using generic or disease-specific measurements. Generic measurements can be applied to any health problems by assessing multiple domains of functioning; in contrast, disease-specific measurements are designed to identify specific health problem-related quality of life. Disease-specific measurements tend to be more sensitive than the generic ones. There is no disease-specific quality of life questionnaire for MetS, so generic instruments such as SF-36 questionnaire, which has been the most frequently used questionnaire, offer the only viable option at present. Because those various generic measurements focus on different aspects of quality of life, the inconsistent results were expected to be observed among studies. Furthermore, some ethnicities may be more reserved in reporting physical and mental health complaints even though the study enrolled participants with same ethnicity. It is inherently inevitable to produce measurement errors, especially in the assessment of psychiatric symptoms. Lastly, appropriate treatment, convenient medical approach, lifestyle promotion intervention, and effective health-related education improved MetS control and HRQoL scores. These studies were not certain about the programs and treatments that the
Table 5  Studies reporting the relation between MetS and health-related quality of life (HRQoL) using SF-36 questionnaire

| Author/year     | Number | Ethnicity/setting                                      | Design                  | Comment                                                                 |
|-----------------|--------|-------------------------------------------------------|-------------------------|-------------------------------------------------------------------------|
| Scholtz et al 2007<sup>27</sup>  | 1212   | Elder American men and women                           | Cross-sectional         | Insulin resistance is associated with poor HRQoL in physical health but not in mental health. |
| Tsai et al 2008<sup>14</sup>     | 361    | American obese men and women                           | Randomized control trial | Participants with MetS had lower HRQoL, especially at lower scores in PCS. |
| Firsman et al 2009<sup>28</sup>  | 1007   | Swedish men and women                                  | Cross-sectional         | MetS associated with lower score of SF-36 in women.                     |
| Huang et al 2010<sup>17</sup>    | 140    | Taiwanese men and women                                | Cross-sectional         | MetS not associated with HRQoL.                                         |
| Liu et al 2010<sup>29</sup>      | 11     | Australian men and women                               | Prospective             | Tai Chi and Qigong improved HRQoL of participants with MetS.            |
| Oh et al 2010<sup>30</sup>       | 52     | Korean men and women                                   | Randomized control trial | Participants with lifestyle intervention resulted in a greater decrease in MetS than those with no intervention. |
| Zhang et al 2010<sup>10</sup>    | 1785   | American men and women with coronary artery disease    | Retrospective           | Patients with MetS had lower score of SF-36.                            |
| Amiri et al 2010<sup>31</sup>    | 950    | Iranian men and women                                  | Cross-sectional         | MetS associated with poor HRQoL in women.                                |
| Hjelset et al 2010<sup>32</sup>  | 198    | Pakistani immigrant women in Norway                    | Cross-sectional         | Women with MetS had lower scores in PCS than women without MetS.        |
| Vetter et al 2011<sup>15</sup>   | 390    | American obese men and women with at least one additional criteria for MetS | Cross-sectional         | MetS not associated with HRQoL.                                         |
| Katano et al 2012<sup>18</sup>   | 4480   | Japanese men and women                                  | Cross-sectional         | MetS associated with poor HRQoL in men and women.                        |
| Tziallas et al 2012<sup>5</sup>  | 359    | Greek men and women                                    | Cross-sectional         | MetS associated with lower scores in PCS and MCS of HRQoL.             |
| Amiri et al 2014<sup>33</sup>    | 630    | Iranian women                                          | Cross-sectional         | MetS is associated with poor HRQoL in reproductive age but not in postmenopausal women and the association mainly related to physical rather than mental health. |
| Amiri et al 2015<sup>34</sup>    | 950    | Iranian men and women                                   | Cross-sectional         | MetS associated with poor PCS in women. Age and smoking are the most important sociodemographic factors affecting the gender-specific association in the MCS. |
| Jahangiry et al 2016<sup>35</sup> | 317    | Iranian men and women                                   | Cross-sectional         | People with MetS experienced lower HRQoL than without MetS. High BP and abdominal obesity are associated with lower HRQoL in participants with MetS. |
| Donini et al 2016<sup>36</sup>   | 253    | Italian men and women                                   | Cross-sectional         | MetS not associated with HRQoL.                                         |
| Hatami et al 2016<sup>20</sup>   | 946    | Iranian men and women                                   | Cross-sectional         | MetS associated with poor PCS of HRQoL in women but not men.            |
| Amiri et al 2018<sup>37</sup>    | 950    | Iranian men and women                                   | Cross-sectional         | The association between MetS and HRQoL followed a sex-specific pattern, mainly significant only in women and in the physical aspect. |
| The current study                | 2588   | Taiwanese men and women                                 | Cross-sectional         | MetS not associated with HRQoL. Hypertension and abdominal obesity are associated with lower HRQoL in participants with MetS. |

BP, bodily pain; MCS, mental component summary; MetS, metabolic syndrome; PCS, physical component summary; SF-36, 36-Item Short-Form Health Survey.
participants may have been exposed to previously, potentially through the local medical service or exposure to government media health promotion campaigns. Taken together, it is necessary to conduct further longitudinal studies using MetS-specific questionnaire to confirm this relationship and verify whether this relationship is linear or only a correlation factor.

The current study must be interpreted in the light of certain limitations, namely, cross-sectional studies do not allow causal relationship inferences underlying the observed associations to be drawn and reverse causation may have played a role in our results. Furthermore, the current study only allowed the calculation of summary scales (two domains: PCS and MCS), but it did not allow the calculation of individual subscales (eight dimensions). Thus, the difference between the MetS and non-MetS groups may have been present in the subscales that were not detected. We replaced eight individual subscales to two summary scales and performed multivariate analysis using logistic regression model again. We found that PF (OR=1.389, p=0.039) and MH (OR=1.412, p=0.042) were able to contribute to MetS development independently. Furthermore, it should be more informative if we were able to contribute to MetS development independently. 

Conclusions: This study showed no correlation between MetS and impaired HRQoL among Taiwanese adults aged ≥30 years, using SF-36 questionnaire. Instead, old age, high BMI, low educational level, bad self-perceived health status and betel nut usage are associated with the prevalence of MetS. For participants with MetS, their physical health was correlated with abdominal obesity, and their mental health was correlated with hypertension. Larger and longitudinal studies that use MetS-specific questionnaire, along with important covariates described previously, are warranted to confirm our observations in this study.

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