

The Association of Quality of Life and Personality Characteristics with Adolescent Metabolic Syndrome: A Cohort Study

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Abstract

Background: Increased prevalence of adolescent metabolic syndrome (MS) is a tracking factor for adulthood cardiovascular diseases. This study aimed to explore the potential relationship of quality of life (QoL) and personality traits with adolescent MS.

Methods: 1961 participants aged 11.68 years from a cohort study established in 2014 and followed in 2019 was included in Chongqing. Quality of life (QoL) and Eysenck's personality questionnaire and MS components were collected.

Results: The prevalence of adolescent MS is 4.69% (95% confidence interval, 3.84%-5.72%). Higher QoL domain score of physical activity ability (PAA) was a protective factor for both MS and MS score (all $P < 0.01$), which was mainly negatively correlated with central obesity, diastolic blood pressure (DBP) and triglycerides levels, and positively correlated with high density lipoprotein cholesterol (HDL-C) level. Total score of QoL was negatively correlated with triglycerides level and positively correlated with DBP (all $P < 0.01$). High extraversion personality score was a protective factor of adolescent MS ($P = 0.04$) and MS score ($P = 0.06$), which was mainly negatively correlated WC systolic blood pressure and TGs, and positively correlated with HDL-C (all $P \leq 0.01$).

Conclusions: QoL score and extraversion personality score were independent protective factors for both MS prevalence and MS score, suggesting the community intervention to improve the QoL and psychological health of children is essential.

Introduction

The increased prevalence of adolescent metabolic syndrome (MS) or MS components severity scores were independent predictors of adulthood cardiovascular diseases (CVDs) [1, 2]. MS components in adolescents includes central obesity, elevated triglycerides (TGs), reduced high density lipoprotein cholesterol (HDL-C), elevated blood pressure and impaired fasting glucose. The prevalence of MS in adolescents ranged from 3.5–11.2% among adolescents according different region and different diagnosed criteria [3, 4]. Current studies[5, 6] have found that shared genetic and environmental factors, family history of CVD and obesity, maternal gestational diabetes[7], low birth weight, early adiposity, social economic status (SES)[8], short duration of sleep[9], excessive screen time, dietary factors, low physical activity, and tobacco smoke exposure were the potential risk factors of adolescent MS or MS components. Literature consistently provides evidence for physical health risks and socioeconomic status associated with adolescent MS or its' components; however, the association of health-related quality of life (QoL) and personality traits with adolescent MS should also gain attention of the researchers.

Limited studies[10] have illustrated the inverse relationship of QoL with MS or MS components mainly in adults, and the conclusions were controversial. However, majority studies found the association only existed in women[11], or only existed in subjects with depression [12]. Previous studies revealed the QoL domain score of physical health[13], social relation[14], but not in mental health and perceived stress domains, were correlated with MS. Moreover, the impact factors of QoL were age, obesity, puberty development stage, SES, physical activity[15, 16] and unhealthy dietary behaviour[17], which were also correlated with MS. In addition, the community obesity intervention study[18] elucidated the control of obesity was associated with the QoL improvement. However, there are no published study exploring the association of QoL score with adolescent MS, and revealed which QoL domains have salient effect.

Personality traits may impact MS and its components, while there are few studies investigated this association. Study found children with obesity may experience number of psycho-social problems[19]. A study found that extraverted personality is positively correlated with TG, fasting blood-glucose (FBG) and MS score in adults [20]. However, to our knowledge, there are no studies exploring the correlation between personality traits and MS in adolescent aged 10 ~ 14 years during puberty development stage in a rural-urban cohort study.

In this study, we investigated, whether QoL scores were inversely correlated with adolescent MS and MS components, which domains have salient effect, and if the association would independent of age, sex, region and other variables. We investigated, if personality traits (extraversion, neuroticism, psychoticism) would associate with MS and MS components, and if the association would independent of the influence of sex, age and other factors.

Methods

Subjects

Two stage stratified cluster sampling was used to include participants from two counties in Chongqing that represent urban and rural areas; then, two regions per county were randomly selected, and finally, 3067 children (including 2808 children entered the cohort in 2014, and 130 children and 129 children transferred into the target schools in 2015 and in 2019) were informed and included if they satisfied the inclusion criteria. In addition, a birth-cohort in which retrospective and prospective variables were adjusted to evaluate the correlation of QoL and personality with MS. Participants who met all the following criteria were recruited: (1) aged between 6 and 9 years in 2014, (2) resided in the target region for more than 6 months, (3) did not have serious diseases (e.g., nephropathy, cardiovascular disease or cancer), and (4) obtained consent from the parents and children for participation. The sample size was calculated with the following parameters: a level of 0.05, power of 90%, prevalence of MS components of 15% and the prevalence in population 10%, using the formula

$$n = p(1 - p) \left(\frac{z_{1-\alpha/2} + z_{1-\beta}}{p - p_0} \right)^2$$

; assuming an attrition rate of 20%, 1859 participants were ultimately needed, and 1961 subjects were ultimately included in this study (as shown in Figure 1). At baseline, all participants completed SES and family health history questionnaires and were recruited mainly from grade one and grade two from primary public-schools screening of children whose families were interested in health research. The questionnaires were administered and collected by the teachers. The Institutional Review Board at the Children's Hospital of Chongqing Medical University gave its approval for the study. Informed consent was provided by all subjects and parents/guardians.

Demographic Variables

Demographic information, SES and prenatal variables included maternal preconception obesity, increased body mass index (BMI) of mother during pregnancy, birth with caesarean section, premature delivery (<37 weeks), birth weight, breastfeeding, gestational hypertension (GH) and gestational diabetes were collected.

The validity and reliability of the demographic questionnaire were checked, and were described in detail in a previous publication[21]. The demographic questionnaire was filled by the parents or guardians of the children after standard training by the research group and the detail instruction of the questionnaire was given to the parents or guardians.

Physical Examination

Anthropometric measurements were conducted both in 2014 and in 2019 by well-trained pediatric nurses, and the protocol for these measurements was described in a previous publication[21]. Waist circumference (WC) was used as an alternative measure of central adiposity. Hip circumference was measured twice horizontally at the level of the pubic symphysis in the front and the gluteus maximus in the back, with the participant standing upright and with their legs together and placing their arms naturally at their sides; the mean value was used.

Blood pressure (BP) was measured on three separate occasions with an OMRON arm-type electronic sphygmomanometer (HEM7051) using an appropriately sized BP cuff placed on the subject's right arm, with the subject in a seated position, which was described detailed in a previous publication[21].

Biochemical Indexes

The biochemical markers of FBG, HDL-C, TG, low density lipoprotein cholesterol (LDL), total cholesterol (TC) were measured in 2014 and in 2019. Venous blood (3 ml) was drawn from each subject in the morning after at least 12 hours of fasting and 24 hours of abstaining from high-fat and spicy foods. The biochemical markers were measured within 2 hours after venous blood was drawn and the protocol was introduced in detail in our previous publication [21].

Measurement of QoL and Eysenck's Personality Questionnaire (EPQ)

The QoL questionnaire for adolescents consists of 49 items, including 4 factors (psychosocial function, physical and mental health, living environment and QoL satisfaction) and 13 dimensions, such as self-satisfaction, relationship of teacher and pupil, physical feeling, companionship, parenthood, physical activity ability(PAA), learning ability and attitude, self-esteem, negative emotion, attitude towards doing homework, opportunity for activity, living convenience and others (picky-eating and surroundings), which was detailed expressed in supplementary figure 1. The order of presentation of the 49 items was randomized. Children rated the statements on a 4-point scale, and the direction of response (positive or negative) varied item by item to limit response bias. Individual item values were recoded prior to analysis so that the direction was consistent. Responses were summed and normalized according to the age-, sex- and region-specific norms of Chinese into a score T(range, 0-100), using the function of $T=50+(X-M)/SD \times 10$, with higher scores suggesting a better QoL status [22].

The Chinese version of Eysenck's personality questionnaire[23] consisted of 88 items scored on a 2-point scale (for positive items NO=0 and YES=1), including 4 domains: extraversion (E) (25 items), neuroticism (N) (23 items), psychoticism (P) (18 items), and lie scales (L) (22 items). High scorers on the E scale indicate sociable, exciting, pleasurable, carefree, and aggressive characteristics. A higher score on the N scale is more likely to be a worried and moody person who tends to suffer from emotional and psychosomatic disorders. The P scale was designed to measure behaviour patterns that might be considered schizoid or psychopathic in extreme cases. The L scale assesses response bias. Items in the E, N, P and L domains are summed and normalized to the age- and sex-specific norm into a score ranging from 0 to 100, using the function of $T=50+(X-M)/SD \times 10$. People are defined as middle type, tendency type and typical type if the T score (E and N) ranges from 43.3~56.7, 38.5~43.3 or 56.7~61.5, <38.5 or >61.5. People were considered psychotic personality if T score of the P domain >56.7. And we consider it was an invalid response of personality traits if the T score of the L domain was >70.

50 samples were required to fill the same questionnaire twice for one-week interval to check the validity and reliability of the QoL and Eysenck's Personality Questionnaires before our formal survey. QoL and Eysenck's Personality Questionnaires were filled by the adolescents after a standard training.

Diagnostic Criteria

The MS of adolescents was defined by the presence of three or more of the following five components [5, 24]: (1) central obesity defined as ≥ 90 th percentile for age and gender criteria from China[25]; (2) elevated systolic and/or diastolic blood pressure ≥ 90 th percentile for age, sex and height (according to the study from Jie Mi[26]); (3) hypertriglyceridemia defined as $TG \geq 1.24$ mmol/L; (4) low serum HDL-C defined as $HDL-C \leq 1.03$ mmol/L, and (5) impaired fasting glucose (IFG) defined as $FBG \geq 5.6$ mmol/L. Next, individual MS score was calculated by sum the number of MS components present (range, 0–5).

The definitions of size for gestational age used the global reference for fetal-weight and birthweight percentiles[27]: birth weight at or above the 90th percentile indicated large for gestational age (LGA), and birth weight less than the 10th percentile indicated small for gestational age (SGA), using the parameters of mean birthweight at 40.5 weeks of 3332.93 g and a variation coefficient of 14.36%. Maternal overweight and obesity before pregnancy was indicated by a BMI of 24~27.9 kg/m² and a BMI ≥ 28 kg/m², respectively; BMI < 18.5 kg/m² was defined as a low BMI [28]. According to guidelines of the Institute of Medicine (IOM) for maternal pregnancy weight gain [29], the recommendation is for underweight, normal weight, overweight, and obese women to gain 12.5~18.0 kg, 11.5~16.0Kg, 7.0~11.5 kg, and 5.0~9.0 kg, respectively; if weight gain exceeded that range, weight gain was defined as "above IOM guidelines", and if weight gain was below that range, was defined as "below the IOM guidelines".

Statistical Analyses

Differences in anthropometric measures, serum biochemical indexes, QoL and personality score among three groups were assessed using ANOVA, and post-hoc comparison was performed using Student-Newman-Keuls (SNK) test. The χ^2 test was used to test the difference in the component ratio of potential risk factors of MS components. Logistic regression model was performed using diagnosed MS components or MS as the dependent variables with QoL and personality traits, as independent variables, and adjusted for covariables. In addition, a generalized linear model (GLM) was used to analyse the correlation of QoL and personality traits scores with MS components levels and MS score, adjusted covariables.

The data analysis was conducted using SAS 9.4 software (Copyright © 2020 SAS Institute Inc. Cary, NC, USA). A significant difference was defined by an α level of 0.05.

Results

General characteristics

The general characteristics of the subjects were revealed in Table 1. A total of 1961 samples were included, with a follow up rate of 63.94% (1961/3067), and the mean age was 11.68 ± 0.60 years (7.26 ± 0.59 years at baseline), and 52.01% (1,020/1,961) were males. The prevalence of adolescent MS was 4.69% (92/1961), and the prevalence of MS components were 21.83% (428/1961), 25.45% (499/1961), 9.28% (182/1961), 9.79% (192/1961) and 1.53% (30/1961) for central obesity, elevated TG, reduced HDL-C, elevated BP, and IFG, respectively. Anthropometric measures; biochemical indexes; MS components; perinatal, and SES variables; QoL score; and personality characteristics among MS groups were shown in Table 1. Anthropometric measures of elevated BMI, WC, systolic blood pressure (SBP) and diastolic blood pressure (DBP) and biochemical indexes of FBG, TG and LDL-C, and decreased HDL-C measured in 2014 were risk factors of adolescent MS in 2019. Age, region, fetal weight of pregnancy week and mother's education level showed significant difference among three groups (no MS component, 1 ~ 2 MS components and MS) (all $P < 0.05$), which were adjusted in the multivariable analysis.

Table 1
General characteristics of adolescent QoL and personality traits with MS study

Variables	All	Metabolic syndrome (MS)			P
		No	1 ~ 2 MS Components	Yes	
Sample size	1961	1052(53.65%)	817(41.66%)	92(4.69%)	
Region					
Urban	1467(74.81%)	829(78.80%)	576(70.50%)	62(67.39%)	< 0.01
Rural	494(25.19%)	223(21.20%)	241(29.50%)	30(32.61%)	
Gender, male (n (%))	1020(52.01%)	554(52.66%)	415(50.8%)	51(55.43%)	0.58
Age, y	11.68 ± 0.60	11.65 ± 0.60	11.72 ± 0.60	11.75 ± 0.60	0.04
Anthropometric measures in 2014					
Age, y	7.26 ± 0.59	7.24 ± 0.59	7.28 ± 0.58	7.29 ± 0.60	0.33
Height, cm	124.52 ± 6.11	123.67 ± 5.86 _a	125.27 ± 6.15 _b	127.57 ± 6.72 _c	< 0.01
Weight, kg	25.92 ± 5.58	24.27 ± 4.13 _a	27.27 ± 5.98 _b	32.65 ± 7.61 _c	< 0.01
BMI, kg/m ²	16.59 ± 2.53	15.79 ± 1.82 _a	17.24 ± 2.75 _b	19.84 ± 3.09 _c	< 0.01
Waist circumference, cm	55.69 ± 7.09	53.59 ± 5.55 _a	57.40 ± 7.48 _b	64.23 ± 8.46 _c	< 0.01
SBP, mmHg	100.6 ± 8.94	98.85 ± 8.36 _a	102.14 ± 9.04 _b	106.70 ± 9.33 _c	< 0.01
DBP, mmHg	62.68 ± 7.76	61.57 ± 7.51 _a	63.72 ± 7.79 _b	66.08 ± 8.04 _c	< 0.01
Anthropometric measures in 2019					
Height, cm	151.75 ± 7.98	150.22 ± 7.89 _a	153.21 ± 7.67 _b	156.33 ± 7.59 _c	< 0.01
Weight, kg	44.30 ± 10.98	39.63 ± 7.69 _a	48.58 ± 11.24 _b	59.62 ± 11.30 _c	< 0.01
BMI, kg/m ²	19.07 ± 3.76	17.45 ± 2.50 _a	20.58 ± 4.01 _b	24.22 ± 3.32 _c	< 0.01
Waist circumference, cm	65.83 ± 10.03	61.20 ± 5.98 _a	70.06 ± 10.77 _b	81.18 ± 8.26 _c	< 0.01
Hip circumference, cm	81.68 ± 8.28	78.45 ± 6.49 _a	84.68 ± 8.41 _b	92.05 ± 6.58 _c	< 0.01
SBP, mmHg	105.71 ± 9.49	102.76 ± 8.02 _a	108.29 ± 9.62 _b	116.62 ± 9.36 _c	< 0.01
DBP, mmHg	62.82 ± 6.70	61.40 ± 5.87 _a	63.98 ± 7.07 _b	68.72 ± 7.05 _c	< 0.01
Puberty	536(27.33%)	267(25.38%)	246(30.11%)	23(25.00%)	0.11
Serum biochemical indexes in 2014					
FBG, mmol/l	4.12 ± 0.6	4.07 ± 0.59 _a	4.17 ± 0.58 _{ab}	4.29 ± 0.71 _b	< 0.01
TC, mmol/l	3.51 ± 0.72	3.49 ± 0.75	3.54 ± 0.68	3.62 ± 0.69	0.25
TG, mmol/l	0.91 ± 0.53	0.82 ± 0.42 _a	0.99 ± 0.58 _b	1.36 ± 0.78 _c	< 0.01
HDL-C, mmol/l	1.26 ± 0.27	1.30 ± 0.27 _a	1.23 ± 0.27 _b	1.10 ± 0.22 _c	< 0.01
LDL-C, mmol/l	1.73 ± 0.56	1.68 ± 0.53 _a	1.78 ± 0.59 _a	1.99 ± 0.63 _b	< 0.01
Serum biochemical indexes in 2019					
FBG, mmol/l	4.45 ± 0.43	4.45 ± 0.38	4.45 ± 0.49	4.50 ± 0.51	0.58
TC, mmol/l	3.52 ± 0.61	3.53 ± 0.57	3.50 ± 0.66	3.47 ± 0.62	0.43
TG, mmol/l	1.06 ± 0.50	0.83 ± 0.20 _a	1.26 ± 0.55 _b	1.85 ± 0.84 _c	< 0.01
HDL-C, mmol/l	1.44 ± 0.31	1.55 ± 0.28 _a	1.34 ± 0.28 _b	1.06 ± 0.20 _c	< 0.01
LDL-C, mmol/l	1.84 ± 0.44	1.81 ± 0.42 _a	1.86 ± 0.46 _a	1.94 ± 0.46 _b	< 0.01
Metabolic syndrome components					

Variables	All	Metabolic syndrome (MS)			P
		No	1 ~ 2 MS Components	Yes	
Central obesity	428(21.83%)		341(41.74%)	87(94.57%)	< 0.01
Elevated triglycerides	499(25.45%)		416(50.92%)	83(90.22%)	< 0.01
Reduced HDL-C	182(9.28%)		122(14.93%)	60(65.22%)	< 0.01
Elevated blood pressure	192(9.79%)		141(17.26%)	51(55.43%)	< 0.01
Impaired fasting glucose	30(1.53%)		27(3.30%)	3(3.26%)	< 0.01
Perinatal measures					
Maternal pre-conception obesity					
Low weight	1079(69.88%)	579(70.70%)	452(69.54%)	48(64.00%)	0.28
Normal weight	317(20.53%)	173(21.12%)	126(19.38%)	18(24.00%)	
Overweight/Obesity	148(9.59%)	67(8.18%)	72(11.08%)	9(12.00%)	
Pregnancy weight gain of mother					
Below IOM guidelines	473(30.85%)	265(32.72%)	182(28.04%)	26(35.14%)	0.15
Within IOM guidelines	598(39.01%)	319(39.38%)	251(38.67%)	28(37.84%)	
Above IOM guidelines	462(30.14%)	226(27.90%)	216(33.28%)	20(27.03%)	
Gestational age of mother, y	27.32 ± 5.02	27.23 ± 4.90	27.45 ± 5.18	27.21 ± 5.03	0.66
Gestational age of father, y	30.29 ± 5.34	30.26 ± 5.28	30.38 ± 5.34	29.87 ± 6.04	0.68
Birth weight, g	3270.4 ± 493.64	3255.8 ± 489.15	3290.6 ± 502.09	3262 ± 469.64	0.34
Premature delivery					
No	1482(88.90%)	801(89.90%)	611(87.79%)	70(87.50%)	0.38
Yes	185(11.10%)	90(10.10%)	85(12.21%)	10(12.50%)	
Fatal weight of pregnancy week					
Appropriate for gestational age	1097(68.18%)	599(69.41%)	444(66.37%)	54(70.13%)	0.04
Small for gestational age	126(7.83%)	79(9.15%)	43(6.43%)	4(5.19%)	
Large for gestational age	386(23.99%)	185(21.44%)	182(27.20%)	19(24.68%)	
Gestational hypertension					
No	1482(88.90%)	801(89.90%)	611(87.79%)	70(87.50%)	0.65
Yes	185(11.10%)	90(10.10%)	85(12.21%)	10(12.50%)	
Gestational diabetes					
No	1816(97.16%)	980(97.32%)	748(97.14%)	88(95.65%)	0.83
Yes	53(2.84%)	27(2.68%)	22(2.86%)	4(4.35%)	
Smoke during pregnancy					
No	1845(98.51%)	994(98.61%)	760(98.32%)	91(98.91%)	0.26
Yes	28(1.49%)	14(1.39%)	13(1.68%)	1(1.09%)	
Birth with cesarean section					
No	1533(87.90%)	816(87.55%)	649(88.90%)	68(82.93%)	0.19
Yes	211(12.10%)	116(12.45%)	81(11.10%)	14(17.07%)	
Socioeconomic measures					
Income, Yuan/year					
~ 50,000	603(32.40%)	305(30.47%)	267(34.59%)	31(35.23%)	0.42
~ 150,000	783(42.07%)	435(43.46%)	314(40.67%)	34(38.64%)	

Variables	All	Metabolic syndrome (MS)			P
		No	1 ~ 2 MS Components	Yes	
> 150,000	475(25.52%)	261(26.07%)	191(24.74%)	23(26.14%)	
Marriage status					
Double parents	1637(91.76%)	877(92.12%)	681(91.04%)	79(94.05%)	0.53
Single parents	147(8.24%)	75(7.88%)	67(8.96%)	5(5.95%)	
Mother's education, y					
~ 9	641(33.42%)	335(32.56%)	283(35.42%)	23(25.56%)	0.04
~ 12	660(34.41%)	363(35.28%)	254(31.79%)	43(47.78%)	
≥ 15	617(32.17%)	331(32.17%)	262(32.79%)	24(26.67%)	
Father's education, y					
~ 9	536(27.96%)	285(27.75%)	227(28.38%)	24(26.67%)	0.96
~ 12	695(36.25%)	368(35.83%)	292(36.50%)	35(38.89%)	
≥ 15	686(35.79%)	374(36.42%)	281(35.13%)	31(34.44%)	
Mother's occupation					
Manager	105(5.50%)	54(5.27%)	41(5.14%)	10(11.49%)	0.06
worker	653(34.21%)	342(33.37%)	276(34.63%)	35(40.23%)	
Technician/Researcher	59(3.09%)	36(3.51%)	19(2.38%)	4(4.60%)	
Farmer	522(27.34%)	270(26.34%)	234(29.36%)	18(20.69%)	
Other	570(29.86%)	323(31.51%)	227(28.48%)	20(22.99%)	
Father's occupation					
Manager	156(8.23%)	90(8.83%)	58(7.33%)	8(9.30%)	0.06
worker	659(34.76%)	343(33.66%)	282(35.65%)	34(39.53%)	
Technician/Researcher	163(8.60%)	95(9.32%)	59(7.46%)	9(10.47%)	
Farmer	529(27.90%)	266(26.10%)	247(31.23%)	16(18.60%)	
Other	389(20.52%)	225(22.08%)	145(18.33%)	19(22.09%)	
13 domains of QoL					
Self-satisfy	50.07 ± 11.35	49.81 ± 11.32	50.54 ± 11.40	48.99 ± 11.18	0.25
Relationship of teacher and pupil	53.59 ± 10.08	53.50 ± 9.97	53.82 ± 10.09	52.67 ± 11.29	0.53
Physical feeling	49.94 ± 10.75	49.97 ± 10.57	49.99 ± 10.89	49.25 ± 11.61	0.82
Companionship	53.74 ± 10.51	53.42 ± 10.46	54.33 ± 10.30	52.24 ± 12.49	0.07
Parenthood	51.27 ± 11.36	51.18 ± 11.17	51.45 ± 11.70	50.81 ± 10.64	0.82
Physical activity ability	50.14 ± 10.66	50.93 ± 10.45 _a	49.48 ± 10.80 _a	46.89 ± 10.84 _b	< 0.01
Learning ability and attitude	51.77 ± 10.24	51.50 ± 10.15	52.26 ± 10.16	50.53 ± 11.69	0.14
Self-esteem	50.34 ± 11.06	50.17 ± 10.96	50.76 ± 11.09	48.64 ± 11.83	0.17
Negative emotion	47.71 ± 11.25	47.57 ± 11.26	48.05 ± 11.09	46.41 ± 12.47	0.34
Attitude of doing homework	51.47 ± 9.06	51.57 ± 8.92	51.48 ± 9.05	50.25 ± 10.77	0.41
Activity opportunity	54.60 ± 9.62	54.16 ± 9.59	55.26 ± 9.64	53.69 ± 9.46	0.03
Living convenience	54.45 ± 7.73	54.28 ± 7.60	54.57 ± 7.96	55.18 ± 7.18	0.47
Other (picky-eating and surroundings)	50.66 ± 10.12	50.04 ± 10.24 _a	51.25 ± 9.93 _a	52.49 ± 10.03 _b	< 0.01
Four factors of QoL					
Psychosocial health factor	64.79 ± 10.37	64.64 ± 10.19	65.18 ± 10.46	63.13 ± 11.45	0.46

Variables	All	Metabolic syndrome (MS)			P
		No	1 ~ 2 MS Components	Yes	
Physical and mental health factor	35.87 ± 5.98	35.89 ± 5.87	35.94 ± 6.06	35.12 ± 6.50	0.16
Living environment factor	24.01 ± 4.28	24.14 ± 4.24 _a	23.94 ± 4.33 _a	23.11 ± 4.19 _b	0.07
Quality of life satisfaction factor	24.90 ± 4.37	24.75 ± 4.40	25.11 ± 4.36	24.79 ± 4.21	0.21
Total score of QoL	52.61 ± 12.37	52.47 ± 12.17 _{ab}	53.06 ± 12.56 _a	50.33 ± 12.85 _b	0.12
Personality Characteristics					
Extraversion (E)	50.30 ± 13.04	50.69 ± 13.19 _a	50.13 ± 12.86 _a	47.33 ± 12.67 _b	0.05
Neuroticism (N)	50.28 ± 14.67	50.48 ± 14.55	49.80 ± 14.60	52.31 ± 16.59	0.26
Psychoticism (P)	39.86 ± 8.96	39.92 ± 8.94	39.71 ± 8.86	40.58 ± 10.11	0.66
Lie (L)	53.43 ± 8.89	53.41 ± 8.67	53.41 ± 9.09	53.89 ± 9.68	0.88
a b c: the difference among groups using "a", "b", "c" labelled, different letters mean the difference existed between two groups; IOM:2009 Institute of Medicine					

QoL and personality traits scores of children with different MS component score in 2019

Table 1 displays the QoL and personality traits scores of children with different MS component score. Adolescents with MS had lower QoL domain score of PAA, activity opportunity and other (picky-eating and surroundings) than counterparts with no or 1 ~ 2 MS components ($P < 0.01$, $P = 0.03$ and $P < 0.01$). In addition, extraversion score of personality traits was decreased in children with MS compared with counterparts with no or 1 ~ 2 MS components ($P = 0.05$).

Relationship of elevated MS components in 2014 with QoL and personality scores in 2019

The results of Logistic regression model in Table 2 showed the relationship of MS components in 2014 with QoL and personality traits in 2019 with after adjusting for age, sex, region, fetal weight of pregnancy week and mother's education level. Central obesity in 2014 induced lower QoL domain score of PAA ($P < 0.01$), living environment factor score of QoL ($P < 0.01$), total score of QoL ($P = 0.06$, borderline significant) and extraversion personality score ($P = 0.06$, borderline significant), while it was positively correlated with higher neuroticism traits in adolescence. And elevated BP in childhood was inversely correlated with QoL domain scores of companionships ($P = 0.05$) and PAA ($P = 0.09$). In addition, elevated TG in childhood caused lower domain score of self-satisfaction ($P = 0.01$) and quality of life satisfaction ($P = 0.05$), and higher neuroticism traits ($P = 0.07$). Decreased HDL in childhood correlated with lower QoL domain scores of physical feeling and negative emotion, and physical and mental health factor score in adolescent (all $P < 0.05$). IFG in childhood was positively correlated with QoL domain scores of self-satisfaction, parenthood, negative emotion, quality of life satisfaction factor scores and the total score of QoL (all $P < 0.05$), and was inversely correlated with neuroticism traits ($P = 0.02$).

Relationship of QoL and personality scores with elevated MS components in 2019

The association of elevated MS components in 2019 with adolescent QoL and personality traits in 2019 was showed in table 2. Elevated domain score of PAA and living environment factor score were protective factors for central obesity (all $P < 0.01$). However, the domain score of other (picky-eating and surroundings) was positively correlated with central obesity, elevated BP and decreased HDL (all $P < 0.05$). The QoL domain scores of self-satisfaction, physical feeling, negative emotion and factor scores of physical and mental health and quality of life satisfaction were positively correlated with elevated BP. Whereas, personality traits scores of neuroticism ($P = 0.06$) and extraversion ($P = 0.02$) were negatively correlated with elevated BP. In addition, elevated domain score of QoL of self-satisfaction, physical feeling, parenthood, PAA, negative emotion, factor score of physical and mental health and total score of QoL were correlated with alleviated elevated TG, while neuroticism score was positively correlated with elevated TG (all $P < 0.05$). The domain scores of physical feeling ($P = 0.04$) and activity opportunity ($P = 0.03$) were positively correlated with IFG.

The relationship of MS components levels in 2014 with QoL and personality scores in 2019

Adjusted for age, sex, region, fetal weight of pregnancy week and mother's education level, the association of MS components in 2014 with QoL and personality traits in 2019 was shown in Table 3. Domain scores of QoL of self-satisfaction ($P = 0.02$), PAA and factor score of living environment (all $P < 0.01$), and extraversion traits ($P < 0.01$) were inversely correlated with WC in 2014, while neuroticism traits ($P = 0.02$) was positively correlated with WC. Elevated SBP in childhood was positively correlated with domain score of physical feeling ($P = 0.04$) and factor score of physical and mental health ($P = 0.02$), and DBP in childhood was inversely correlated with domain score of PAA ($P = 0.01$) and extraversion personality ($P = 0.05$). In addition, higher HDL in childhood would predict higher domain scores of physical feeling ($P = 0.06$), negative emotion ($P = 0.02$), higher factor score of physical and mental health ($P = 0.04$) and total score of QoL ($P = 0.08$), and higher score of extraversion traits ($P = 0.04$). Elevated FBG in childhood was positively correlated with domain score of activity opportunity ($P = 0.05$).

Table 2
Logistic regression analysis of the association of QoL and personality traits with adolescent MS components

Variables	Central obesity		Elevated BP		Elevated TGs		Decreased HDL		Impaired fasting
	OR (95%CI)	P	OR (95%CI)	P	OR (95%CI)	P	OR (95%CI)	P	OR (95%CI)
Part 1:Relationship of elevated MS components in 2014 with QoL and personality scores in 2019*									
13 domains of QoL									
Self-satisfaction	0.988(0.975,1.001)	0.07	0.994(0.982,1.006)	0.31	0.982(0.968,0.997)	0.01	0.996(0.982,1.011)	0.62	1.13(1.009,1.26)
Relationship of teacher and pupil	0.99(0.975,1.005)	0.18	0.992(0.979,1.006)	0.26	1.001(0.984,1.018)	0.93	1.006(0.989,1.023)	0.49	1.07(0.972,1.17)
Physical feeling	0.999(0.985,1.013)	0.86	0.999(0.987,1.012)	0.92	0.99(0.975,1.006)	0.24	0.983(0.968,0.999)	0.03	1.079(0.985,1.174)
Companionship	0.994(0.98,1.008)	0.43	0.988(0.976,1.000)	0.05	0.995(0.98,1.011)	0.57	0.992(0.977,1.007)	0.29	1.029(0.949,1.114)
Parenthood	0.989(0.976,1.003)	0.12	0.994(0.982,1.006)	0.35	0.994(0.979,1.01)	0.47	0.993(0.979,1.008)	0.36	1.112(1.002,1.232)
Physical activity ability	0.969(0.955,0.982)	< 0.01	0.989(0.977,1.002)	0.09	1.002(0.985,1.018)	0.84	0.991(0.976,1.007)	0.27	1.008(0.941,1.075)
Learning ability and attitude	0.994(0.98,1.009)	0.45	0.992(0.979,1.006)	0.27	0.989(0.973,1.006)	0.21	1(0.984,1.016)	0.98	1.002(0.935,1.069)
Self-esteem	0.99(0.976,1.004)	0.17	0.996(0.984,1.008)	0.51	1.004(0.988,1.02)	0.62	0.999(0.984,1.014)	0.90	1.055(0.989,1.121)
Negative emotion	0.995(0.982,1.009)	0.50	1.003(0.991,1.015)	0.67	0.986(0.972,1.001)	0.07	0.985(0.971,1)	0.04	1.085(1.004,1.166)
Attitude of doing homework	0.994(0.978,1.011)	0.48	1.002(0.987,1.017)	0.79	0.993(0.975,1.011)	0.46	1.001(0.983,1.019)	0.91	1.032(0.945,1.119)
Activity opportunity	0.986(0.971,1.002)	0.09	0.993(0.979,1.007)	0.32	0.991(0.973,1.009)	0.31	0.985(0.968,1.002)	0.08	1.066(0.981,1.151)
Living convenience	0.996(0.977,1.016)	0.70	1.009(0.991,1.028)	0.31	1.004(0.982,1.028)	0.72	0.99(0.969,1.011)	0.34	1.039(0.932,1.146)
Other	1.007(0.992,1.023)	0.34	1.007(0.993,1.020)	0.35	0.996(0.979,1.014)	0.69	0.986(0.97,1.002)	0.09	1.065(0.984,1.146)
Four factors of QoL									
Psychosocial	0.988(0.974,1.003)	0.12	0.989(0.976,1.002)	0.10	0.996(0.98,1.013)	0.67	0.997(0.981,1.013)	0.70	1.069(0.983,1.154)
Physical and mental health	0.992(0.967,1.017)	0.54	1.002(0.979,1.025)	0.85	0.978(0.951,1.006)	0.13	0.972(0.946,1)	0.05	1.157(0.99,1.324)
Living environment	0.937(0.903,0.972)	< 0.01	0.982(0.951,1.015)	0.29	0.995(0.954,1.038)	0.82	0.965(0.926,1.005)	0.08	1.105(0.92,1.29)
Quality of life satisfaction	0.978(0.945,1.012)	0.20	0.992(0.962,1.024)	0.63	0.963(0.927,1.000)	0.05	0.981(0.945,1.018)	0.31	1.329(1.028,1.63)
Total score of QoL	0.988(0.976,1.001)	0.06	0.994(0.983,1.005)	0.31	0.993(0.979,1.007)	0.30	0.99(0.977,1.003)	0.14	1.074(1.002,1.146)
Personality Characteristics									
Neuroticism (N)	1.012(1.001,1.022)	0.03	1.001(0.991,1.01)	0.91	1.011(0.999,1.023)	0.07	1.006(0.995,1.017)	0.30	0.907(0.831,0.983)
Psychoticism (P)	1.001(0.984,1.018)	0.93	0.995(0.979,1.011)	0.51	0.999(0.98,1.019)	0.26	0.994(0.975,1.013)	0.55	0.866(0.742,0.99)
Extraversion (E)	0.989(0.977,1)	0.06	0.992(0.982,1.002)	0.13	0.991(0.978,1.004)	0.18	0.989(0.977,1.002)	0.09	0.989(0.938,1.04)
Part 2:Relationship of QoL and personality scores with elevated MS components in 2019*									
13 domains of QoL									
Self-satisfaction	0.997(0.986,1.007)	0.56	1.018(1.002,1.036)	0.03	0.989(0.98,0.999)	0.04	1.004(0.989,1.019)	0.60	1.024(0.983,1.065)
Relationship of teacher and pupil	0.998(0.986,1.01)	0.72	0.996(0.979,1.013)	0.62	0.994(0.983,1.006)	0.33	1.004(0.987,1.021)	0.68	0.983(0.946,1.02)
Physical feeling	0.995(0.984,1.006)	0.38	1.019(1.002,1.037)	0.03	0.989(0.979,1)	0.04	0.998(0.983,1.014)	0.80	1.049(1.002,1.096)

Companionship	0.993(0.982,1.005)	0.25	1.008(0.991,1.025)	0.38	0.994(0.983,1.004)	0.25	1.009(0.992,1.026)	0.29	1.003(0.964
Parenthood	0.998(0.987,1.009)	0.73	1.016(0.999,1.033)	0.07	0.99(0.98,1)	0.05	1.006(0.991,1.022)	0.45	1.005(0.967
Physical activity ability	0.964(0.953,0.975)	< 0.01	0.998(0.982,1.014)	0.79	0.983(0.972,0.994)	< 0.01	1(0.984,1.015)	0.96	1.022(0.981
Learning ability and attitude	0.998(0.986,1.01)	0.70	1.002(0.985,1.02)	0.80	0.993(0.982,1.005)	0.24	0.995(0.979,1.011)	0.55	1.024(0.982
Self-esteem	0.993(0.982,1.005)	0.24	1.003(0.988,1.019)	0.69	0.995(0.985,1.006)	0.38	0.993(0.977,1.008)	0.35	0.985(0.949
Negative emotion	1.001(0.991,1.012)	0.80	1.017(1.001,1.033)	0.04	0.989(0.979,0.999)	0.03	1.003(0.988,1.018)	0.71	1.026(0.988
Attitude of doing homework	0.997(0.984,1.011)	0.66	1.011(0.99,1.031)	0.30	0.991(0.978,1.003)	0.15	0.998(0.98,1.017)	0.84	0.986(0.945
Activity opportunity	0.998(0.985,1.011)	0.74	1.015(0.997,1.034)	0.10	1.002(0.989,1.014)	0.80	0.993(0.976,1.011)	0.46	1.054(1.005
Living convenience	1.003(0.987,1.018)	0.75	1.011(0.988,1.034)	0.36	1.002(0.987,1.017)	0.81	0.998(0.977,1.02)	0.88	1.033(0.972
Other	1.014(1.001,1.026)	0.03	1.027(1.009,1.045)	< 0.01	1.001(0.99,1.013)	0.81	1.024(1.006,1.042)	0.01	1.024(0.982
Four factors of QoL									
Psychosocial	0.994(0.982,1.006)	0.35	1.007(0.989,1.025)	0.45	0.991(0.979,1.002)	0.11	1.003(0.986,1.02)	0.73	0.997(0.957
Physical and mental health	0.994(0.975,1.015)	0.59	1.037(1.006,1.07)	0.02	0.976(0.958,0.995)	0.02	1(0.972,1.029)	0.99	1.056(0.98,1
Living environment	0.948(0.921,0.977)	< 0.01	1.021(0.979,1.065)	0.34	0.98(0.952,1.007)	0.15	0.993(0.953,1.034)	0.72	1.101(0.987
Quality of life satisfaction	1.002(0.975,1.03)	0.88	1.061(1.016,1.107)	0.01	0.978(0.953,1.004)	0.10	1.029(0.988,1.071)	0.16	1.069(0.965
Total score of QoL	0.993(0.983,1.003)	0.17	1.011(0.996,1.026)	0.15	0.989(0.979,0.998)	0.02	1(0.987,1.014)	0.95	1.017(0.981
Personality Characteristics									
Neuroticism (N)	1.003(0.994,1.011)	0.55	0.988(0.976,1)	0.06	1.009(1.001,1.017)	0.03	0.999(0.988,1.011)	0.91	0.984(0.955
Psychoticism (P)	0.999(0.985,1.013)	0.88	0.982(0.961,1.004)	0.10	1.007(0.994,1.02)	0.31	0.991(0.971,1.011)	0.36	1.024(0.986
Extraversion (E)	0.99(0.981,1)	0.04	0.985(0.972,0.998)	0.02	0.992(0.983,1.001)	0.08	0.99(0.977,1.003)	0.12	1.022(0.986
*age, sex, region, fetal weight of pregnancy week and mother's education level were adjusted in GLM model. QoL: quality of life, MS: metabolic syndrome, BP pressure, TGs: triglyceride, HDL: high-density lipoprotein									

Table 3

The Correlation of QoL and Personality Characteristics of adolescent with MS compor

Variables	WC, cm		SBP, mmHg		DBP, mmHg		TGs
	B(SE)	P	B(SE)	P	B(SE)	P	B(SE)
The association of MS components in 2014 with QoL and Personality Traits in 2019*							
13 domains of QoL							
Self-satisfaction	-0.0385(0.0164)	0.02	0.0238(0.0212)	0.26	-0.0154(0.0186)	0.41	-0.00
Relationship of teacher and pupil	-0.0257(0.0187)	0.17	0.0396(0.0242)	0.10	-0.012(0.021)	0.57	-0.00
Physical feeling	-0.0133(0.0176)	0.45	0.0471(0.0227)	0.04	0.0081(0.0197)	0.68	0.00
Companionship	-0.0273(0.0178)	0.13	0.0039(0.0229)	0.86	-0.0263(0.0199)	0.19	-0.00
Parenthood	-0.0187(0.0168)	0.27	0.0173(0.0217)	0.43	-0.0133(0.0189)	0.48	-0.00
Physical activity ability	-0.0881(0.0172)	< 0.01	0.0072(0.0224)	0.75	-0.0485(0.0195)	0.01	-0.00
Learning ability and attitude	0.0009(0.0183)	0.96	0.0063(0.0237)	0.79	-0.038(0.0206)	0.07	-0.00
Self-esteem	-0.0198(0.017)	0.24	0.0307(0.0219)	0.16	-0.0054(0.0191)	0.78	-0.00
Negative emotion	-0.0118(0.0165)	0.48	0.0397(0.0214)	0.06	0.0127(0.0186)	0.50	-0.00
Attitude towards doing homework	-0.0041(0.0208)	0.85	0.0441(0.0269)	0.10	0.0056(0.0234)	0.81	-0.00
Activity opportunity	-0.0205(0.0195)	0.29	-0.0014(0.0252)	0.96	-0.0265(0.0219)	0.23	-0.00
Living convenience	0.0151(0.0245)	0.54	0.0176(0.0316)	0.58	0.0118(0.0276)	0.67	0.00
Other(picky-eating and surroundings)	0.0292(0.0186)	0.12	0.0433(0.024)	0.07	0.008(0.0209)	0.70	-0.00
Four factors of QoL							
Psychosocial	-0.0263(0.0186)	0.16	0.0283(0.024)	0.24	-0.0273(0.0208)	0.19	-0.00
Physical and mental health	-0.026(0.0317)	0.41	0.0979(0.0409)	0.02	0.0199(0.0357)	0.58	-0.00
Living environment	-0.1395(0.0451)	< 0.01	0.0264(0.0585)	0.65	-0.0862(0.0508)	0.09	-0.00
Quality of life satisfaction	-0.0636(0.0429)	0.14	0.0871(0.0553)	0.12	-0.0162(0.0481)	0.74	-0.00
Total score of QoL	-0.0279(0.0154)	0.07	0.0349(0.0199)	0.08	-0.0162(0.0173)	0.35	-0.00
Personality Traits							
Neuroticism (N)	0.0294(0.0129)	0.02	-0.0309(0.0167)	0.07	-0.0038(0.0147)	0.80	0.00
Psychoticism (P)	-0.0046(0.0212)	0.83	-0.0338(0.0274)	0.22	-0.0163(0.024)	0.50	-0.00
Extraversion (E)	-0.0418(0.0146)	< 0.01	-0.0227(0.0191)	0.23	-0.0329(0.0167)	0.05	-0.00
The association of MS components in 2019 with QoL and Personality Traits in 2019*							
13 domains of QoL							
Self-satisfaction	-0.0382(0.0214)	0.08	0.0274(0.0199)	0.17	0.0362(0.0146)	0.01	-0.00

Variables	WC, cm		SBP, mmHg		DBP, mmHg		TGs
	B(SE)	P	B(SE)	P	B(SE)	P	B(SE)
Relationship of teacher and pupil	-0.0147(0.0245)	0.55	0.0233(0.0227)	0.31	0.0274(0.0167)	0.10	-0.00
Physical feeling	-0.0174(0.0226)	0.44	0.0431(0.021)	0.04	0.0551(0.0154)	< 0.01	-0.00
Companionship	-0.0593(0.0231)	0.01	0.0033(0.0215)	0.88	0.0141(0.0158)	0.37	-0.00
Parenthood	-0.0338(0.0219)	0.12	0.0086(0.0203)	0.67	0.0249(0.0149)	0.10	-0.00
Physical activity ability	-0.1658(0.0225)	< 0.01	-0.0056(0.0212)	0.79	-0.0296(0.0156)	0.06	-0.00
Learning ability and attitude	-0.0097(0.024)	0.69	0.0006(0.0223)	0.98	0.0312(0.0164)	0.06	-0.00
Self-esteem	-0.0261(0.0223)	0.24	-0.0075(0.0208)	0.72	0.0146(0.0152)	0.34	-0.00
Negative emotion	-0.0023(0.0217)	0.92	0.0247(0.0202)	0.22	0.0235(0.0148)	0.11	-0.00
Attitude towards doing homework	0.0129(0.0273)	0.64	0.0415(0.0253)	0.10	0.0595(0.0185)	< 0.01	-0.00
Activity opportunity	-0.0237(0.0257)	0.36	-0.0004(0.0238)	0.99	0.0268(0.0175)	0.13	-0.00
Living convenience	-0.0057(0.0317)	0.86	0.0095(0.0295)	0.75	0.0176(0.0216)	0.42	-0.00
Other (picky-eating and surroundings)	0.0624(0.0244)	0.01	0.072(0.0226)	< 0.01	0.0627(0.0166)	< 0.01	0.00
Four factors of QoL							
Psychosocial	-0.0431(0.0242)	0.08	0.0082(0.0225)	0.72	0.0296(0.0165)	0.07	-0.00
Physical and mental health	-0.0146(0.0412)	0.72	0.0809(0.0382)	0.03	0.0981(0.028)	< 0.01	-0.00
Living environment	-0.2627(0.0588)	< 0.01	0.004(0.0549)	0.94	0.0004(0.0403)	0.99	-0.00
Quality of life satisfaction	-0.0383(0.0558)	0.49	0.11(0.0517)	0.03	0.124(0.0379)	< 0.01	-0.00
Total score of QoL	-0.0407(0.0201)	0.04	0.0199(0.0186)	0.28	0.0329(0.0136)	0.02	-0.00
Personality Traits							
Neuroticism (N)	0.0317(0.0169)	0.06	-0.02(0.0157)	0.20	-0.0246(0.0114)	0.03	0.00
Psychoticism (P)	0.0266(0.0279)	0.34	-0.0095(0.0259)	0.72	-0.0288(0.0189)	0.13	0.00
Extraversion (E)	-0.0706(0.0193)	< 0.01	-0.0577(0.018)	< 0.01	-0.0241(0.0131)	0.07	-0.00

*age, sex, region, fetal weight of pregnancy week and mother's education level were adjusted in GLM model. QoL: quality of life, MS: metabolic syndrome, WC: waist circumference, TGs: triglyceride, HDL: high-density lipoprotein, FBG: fasting blood-glucose, ns: non-significance

Table 4 Logistic regression analysis the relationship of QoL and personality traits with adolescent MS

Variables	MS			MS *		
	B	OR (95%CI)	P	B	OR (95%CI)	P
13 domains of QoL						
Self-satisfaction	-0.006	0.994(0.976,1.012)	0.51	-0.006	0.994(0.975,1.012)	0.50
Relationship of teacher and pupil	-0.008	0.992(0.972,1.013)	0.45	-0.008	0.992(0.971,1.013)	0.43

Variables	WC, cm		SBP, mmHg		DBP, mmHg		TGs
	B(SE)	P	B(SE)	P	B(SE)	P	B(SE)
Physical feeling	-0.006	0.994(0.975,1.013)	0.54	-0.007	0.993(0.974,1.013)	0.51	
Companionship	-0.010	0.990(0.971,1.009)	0.31	-0.012	0.988(0.969,1.007)	0.23	
Parenthood	-0.003	0.997(0.978,1.016)	0.76	-0.002	0.998(0.979,1.018)	0.88	
Physical activity ability	-0.035	0.965(0.946,0.985)	< 0.01	-0.034	0.966(0.947,0.986)	< 0.01	
Learning ability and attitude	-0.009	0.991(0.971,1.011)	0.38	-0.010	0.990(0.969,1.011)	0.34	
Self-esteem	-0.013	0.987(0.968,1.007)	0.20	-0.014	0.986(0.966,1.006)	0.16	
Negative emotion	-0.009	0.991(0.973,1.010)	0.35	-0.009	0.992(0.973,1.010)	0.37	
Attitude towards doing homework	-0.015	0.985(0.964,1.007)	0.18	-0.017	0.983(0.962,1.005)	0.14	
Activity opportunity	-0.005	0.995(0.973,1.017)	0.65	-0.007	0.993(0.971,1.015)	0.53	
Living convenience	0.017	1.017(0.987,1.048)	0.28	0.014	1.014(0.984,1.045)	0.36	
Other (picky-eating and surroundings)	0.024	1.024(1.003,1.046)	0.03	0.029	1.029(1.007,1.052)	0.01	
Four factors of QoL							
Psychosocial	-0.014	0.986(0.967,1.006)	0.18	-0.012	0.988(0.967,1.009)	0.25	
Physical and mental health	-0.021	0.979(0.945,1.014)	0.23	-0.020	0.980(0.946,1.015)	0.26	
Living environment	-0.056	0.946(0.900,0.993)	0.03	-0.050	0.952(0.904,1.002)	0.06	
Quality of life satisfaction	0.002	1.002(0.954,1.052)	0.93	0.008	1.008(0.959,1.060)	0.76	
Total score of QoL	-0.014	0.986(0.970,1.003)	0.11	-0.015	0.985(0.968,1.002)	0.09	
Personality Characteristics							
Neuroticism (N)	0.008	1.008(0.994,1.023)	0.26	0.008	1.008(0.993,1.023)	0.28	
Psychoticism (P)	0.008	1.008(0.985,1.031)	0.51	0.008	1.008(0.985,1.032)	0.48	
Extraversion (E)	-0.018	0.982(0.967,0.997)	0.02	-0.016	0.984(0.968,1.000)	0.05	

* Age, sex, region, fetal weight of pregnancy week and mother's education level were adjusted in Logistic regression model (dependent variable value: 1 = with MS, 0 = without any one of five MS components), and 1144 samples were included. QoL: quality of life, MS: metabolic syndrome

Table 5 GLM analysis the association of QoL and personality traits with adolescent MS score

Variables	MS			MS*		
	B	StdErr	P	B	StdErr	P
13 domains of QoL						
Self-satisfaction	0.001	0.002	0.73	0.001	0.002	0.82
Relationship of teacher and pupil	-0.002	0.002	0.38	-0.001	0.002	0.48
Physical feeling	-0.001	0.002	0.76	-0.001	0.002	0.65
Companionship	0.001	0.002	0.87	0.001	0.002	0.94

Variables	WC, cm		SBP, mmHg		DBP, mmHg		TGs
	B(SE)	P	B(SE)	P	B(SE)	P	B(SE)
Parenthood	0.001	0.002	0.83	0.001	0.002	0.95	
Physical activity ability	-0.008	0.002	< 0.01	-0.008	0.002	< 0.01	
Learning ability and attitude	0.001	0.002	0.94	0.001	0.002	0.86	
Self-esteem	-0.001	0.002	0.61	-0.001	0.002	0.51	
Negative emotion	0.001	0.002	0.58	0.001	0.002	0.67	
Attitude towards doing homework	-0.002	0.002	0.30	-0.003	0.002	0.15	
Activity opportunity	0.003	0.002	0.11	0.003	0.002	0.18	
Living convenience	0.001	0.003	0.66	0.001	0.003	0.88	
Other (picky-eating and surroundings)	0.006	0.002	< 0.01	0.007	0.002	< 0.01	
Four factors of QoL							
Psychosocial	-0.002	0.002	0.38	-0.001	0.002	0.66	
Physical and mental health	-0.001	0.003	0.68	-0.001	0.003	0.66	
Living environment	-0.011	0.005	0.02	-0.007	0.005	0.12	
Quality of life satisfaction	0.005	0.005	0.28	0.006	0.005	0.19	
Total score of QoL	-0.001	0.002	0.46	-0.001	0.002	0.40	
Personality Characteristics							
Neuroticism (N)	0.001	0.001	0.93	0.001	0.001	0.93	
Psychoticism (P)	0.001	0.002	0.99	0.001	0.002	0.78	
Extraversion (E)	-0.004	0.002	0.01	-0.003	0.002	0.06	

* Age, sex, region, fetal weight of pregnancy week and mother's education level were adjusted in Logistic regression model. QoL: quality of life, MS scores: having one metabolic syndrome components markers one score.

The relationship of QoL and personality scores with MS components levels in 2019 The linear relationship of QoL and personality traits with MS component levels was revealed in Table 3. After adjusting for age, sex, region, fetal weight of pregnancy week and mother's education level, the QoL domain score of companionship, PAA, factor score of living environment and total score of QoL, and extraversion personality score were negatively correlated WC (all $P < 0.01$). The domain scores of physical feeling, other domain, factor scores of physical and mental health and QoL satisfaction were positively correlated with both SBP and DBP levels, and domain scores of self-satisfaction, attitude towards doing homework, factor score of total score of QoL were positively correlated with DBP level. Whereas, extraversion personality scores were negatively correlated with SBP level ($P < 0.01$), and neuroticism personality score was also negatively correlated with DBP level ($P = 0.03$). The QoL domain scores of self-satisfaction, relationship of teacher and pupil, PAA, negative emotion, and the factor scores of psychosocial, physical and mental health, living environment, quality of life satisfaction and the total score of QoL, and extraversion personality scores were positively correlated with TG. In addition, the domain scores of PAA, learning ability and extraversion traits score was positively correlated with HDL-C (all $P < 0.05$ or $P < 0.01$). QoL domain score of physical feeling was borderline negatively correlated with FBG ($P = 0.05$).

Relationship of QoL and personality traits scores with MS and MS score in 2019 In the multivariable Logistic regression model (Table 4) (adjusted for sex, age, region, fetal weight of pregnancy week and mother's education level), the results showed that QoL domain score of PAA was protective factor for MS ($P < 0.01$), and factor scores of living environment ($P = 0.06$) and total score of QoL ($P = 0.09$) were borderline protective factors of MS. In addition, high score of extraversion personality was a protective factor of MS even adjusted for sex, age, region, fetal weight of pregnancy week and mother's education level. However, QoL score of "other" domain (picky-eating and surroundings) was positively correlated with MS. The GLM (Table 5) also revealed that high score of PAA was protective factor of MS score ($P < 0.01$) and high factor score of living environment was negatively correlated with MS score before adjusted for covariables ($P = 0.02$).

Whereas, high QoL score of “other” domain was positively correlated with MS score ($P < 0.01$). High extraversion personality score was a borderline significant protective factor of MS score after adjusted for covariables ($P = 0.06$).

Discussion

This study is the first prospective cohort study that revealed both the longitudinal and cross-sectional correlation between QoL and MS or MS components, and the association between personality traits and MS or MS components (both in 2014 and in 2019) over an average 12-year follow-up from birth to adolescence in urban-rural areas. We observed that increased prevalence of MS components (both in 2014 and in 2019) and MS, and MS score were associated with QoL score and personality traits. QoL domain score of PAA and extraversion personality score were independent protective factors both for MS and MS score.

Our study revealed centrally obese children and adolescent were mainly negatively correlated with physical QoL scores, such as self-satisfaction, PAA and factor score of living environment, and a dose relationship was found. Our result was coincided with other studies[30–32], which found obesity population had lower health-related QoL (HRQoL) scores, and weight loss would improve HRQoL[33]. In our study centrally obese children even in a young age (6 ~ 8 years) would impact the QoL score in adolescent, suggesting that children with obesity should provide an effect intervention to improve HRQoL. Whereas, the childhood and adolescent obesity were not significant correlated mental aspects of QoL scores in our study just as the results from other studies[31]. In addition, this cohort study indicated that the BP level in childhood and adolescents was inversely correlated with physical QoL score of PAA as the results from adults[34], but positively correlated with mental QoL scores and total score of QoL, and the result of mental QoL score was not coincided with the results from hypertension in adults[35]. Study from Jing Sun et al [36] found the decrease of BP would improve the physical HRQoL score in adults with hypertension, but this conclusion was controversial. Except our study, there are no available data among children where the QoL was compared with elevated blood pressure, and the mechanism should be illustrated in future intervention study.

Research on the relationship between glycolipid indexes and QoL is limited. Study from adult cardiovascular disease illustrated elevated TG level was inversely with both physical and QoL score[34]. Our study first revealed elevated TG in childhood was not correlated QoL scores in adolescent from a prospective perspective, but TG was negatively related with both physical (physical feeling and PAA) and mental (self-satisfaction, relationship of teacher and pupil and attitude towards doing homework) QoL domains scores, factor scores of physical and mental health and Living environment, and total QoL score from a cross-sectional perspective. Previous study[37] of adulthood hypertension found elevated HDL-C was positively correlated with EuroQol five dimensions three levels (EQ-5D-3L) index and EuroQol visual analog scale (EQ VAS) score. Accordingly, we found increased HDL-C in childhood was positively correlated with negative emotion domain score and physical and mental QoL factor score, and was positively correlated with extraversion personality traits in adolescent, and HDL-C level in adolescent was positively with physical (PAA) and mental (“Learning ability and attitude”) QoL scores. Our finds revealed the QoL score about learning ability and attitude has salient effect on lipids level in adolescent, and the mechanism need further research. In addition, FBG and HbA1c levels in Type 1 DM was negatively correlated with EQ-VAS (overall health status)[38], but our cohort study with childhood health population found that IFG in childhood was positively correlated with QoL score of activity opportunity. The controversial results could be explained by the different life style between health children and adult DM, and the different components of QoL questionnaires between adolescents and adult version.

However, a cross-sectional study found QoL scores were correlated with an increase in the components of MS, and the physical health domain of QoL had the most significant association [39]. In our study, we found the PAA domain score and living environment factor score were protective factors of MS and MS score, but other (picky-eating and surroundings) domain score was risk factors of MS and MS score even adjusted other covariates, and the total score of QoL was boundary protective factor of MS. To our knowledge, this is the first cohort study with a large sample size to explore the relationship of QoL with MS and MS score in adolescents.

Personality traits may be associated with MS, but the conclusion remains controversial, and few studies have been conducted in adult populations; no related cohort study has explored this relationship in adolescents. The results from Japanese adults [20] showed the E score was positively correlated with TGs, FBG and MS components, and the P score was positively correlated with FBG. However, we found the E score in adolescents was negatively correlated with MS, central obesity, SBP and positively correlated with HDL, suggesting the E score may be age dependent and have a different impact on lipid metabolism between adults and adolescents. And study from Evans, B. E. [40] reported that extraverted adolescents have less cortisol activity, which is associated with FBG and FI [41]. Therefore, extraversion traits may regulate glycolipid indexes through the hypothalamic–pituitary–adrenal axis pathway [40], which may impact MS by regulating the reactivity of the sympathetic nervous system (SNS) [42], and the SNS will have potent effects on insulin secretion and sensitivity [43] and on lipid metabolism [44]. Adolescents with high N scores would be more prone to responding more strongly to a stressor, and our study didn’t found N correlated with MS, which was not coincided with the results of study in adults [45].

Our study has some limitations that should be considered when interpreting the results. First, as this was a retrospective and prospective cohort study, recall bias may exist for the prenatal variables. We checked the birth certificates to verify the birth weight, stature and gestational age. Second, data on GH and gestational diabetes were collected through a questionnaire, and recall bias existed. However, we collected the same perinatal information both in 2014 and in 2019 independently to reduce recall bias and nonresponsive. Finally, QoL and personality traits were collected in a cross-sectional manner in 2019, which makes it difficult to draw conclusions regarding causality relationships of QoL and personality traits with MS. Whereas, this study explored the relationship of MS components in childhood (in 2014) with the scores of QoL and personality traits in 2019, prospectively.

In conclusion, the prevalence of MS was elevated in adolescents. Higher PAB score was a protective factor for MS and MS score, which was mainly negatively correlated with MS components of central obesity, DBP and TGs, and positively correlated with HDL-C level. Total score of QoL was negatively correlated with TGs and positively correlated with DBP. High extraversion personality score was a protective factor of adolescent MS and MS score, which was mainly

negatively correlated WC and SBP, and positively correlated with HDL-C. To our knowledge, this is the first study to explore the relationship of QoL and personality characteristics with MS in a large-sample-size cohort study of adolescents, and the correlation was significant after adjusting for covariates.

Public Health Meaning

In this study, we found the relationship of QoL and personality traits with MS and MS components both from prospective and cross-sectional aspects after adjusted other covariates. First, physical activity ability score was inversely correlated with MS and MS score, which suggested establish the comprehensive community, family and school intervention model to improve the physical activity ability of children is essential for the control of adolescents MS. Second, the QoL score of other domain including picky-eating and surroundings was positively correlated with MS and MS score, indicating the health education about health dietary habits should be implemented in both family and school to improve the life style. Finally, the extraversion personality traits was a protective factor of MS and MS score, therefore the primary prevention of childhood health should pay attention to cultivate children's extraversion personality.

Abbreviations

MS

metabolic syndrome; CVDs:cardiovascular diseases; TGs:triglycerides; HDL-C:high density lipoprotein cholesterol; SES:social economic status; QoL:quality of life; FBG:fasting blood-glucose; BMI:body mass index; GH:gestational hypertension; WC:waist circumference; BP:blood pressure; LDL:low density lipoprotein cholesterol; TC:total cholesterol; EPQ

Eysenck's Personality Questionnaire; PAA

physical activity ability; E:extraversion; N:neuroticism; P:psychoticism; L:lie scales; IFG:impaired fasting glucose; LGA:large for gestational age; SGA:small for gestational age; IOM:the Institute of Medicine; SNK:Student-Newman-Keuls; GLM:generalized linear model; SBP:systolic blood pressure; DBP:diastolic blood pressure; HRQoL:health-related QoL; SNS:sympathetic nervous system

Declarations

Ethics approval and consent to participate

The Institutional Review Board at the Children's Hospital of Chongqing Medical University gave its approval for the study. Informed consent was provided by all subjects and parents/guardians. Informed consent of participate this study was provided by all subjects and parents/guardians.

Consent for publication

All authors critically reviewed and approved the publication of final paper.

Availability of data and materials

Data are available from Xiaohua Liang (contact via xiaohualiang@hospital.cqmu.edu.cn or liangxiaohua666@sina.com).

Competing interests

Authors have no relevant conflict of interest to disclose.

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Authors' contributions

XH conceived and designed the experiments; PZ and SQ performed the experiments; WF, GF, XT and LJ participated the physical measurement; XH wrote the paper; and all authors critically reviewed and approved the final paper. The authors would like to acknowledge the laboratory support of the Ministry of Education Key Laboratory of Child Development and Disorders and all the staff members of the 6 elementary schools in the two regions.

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Figures

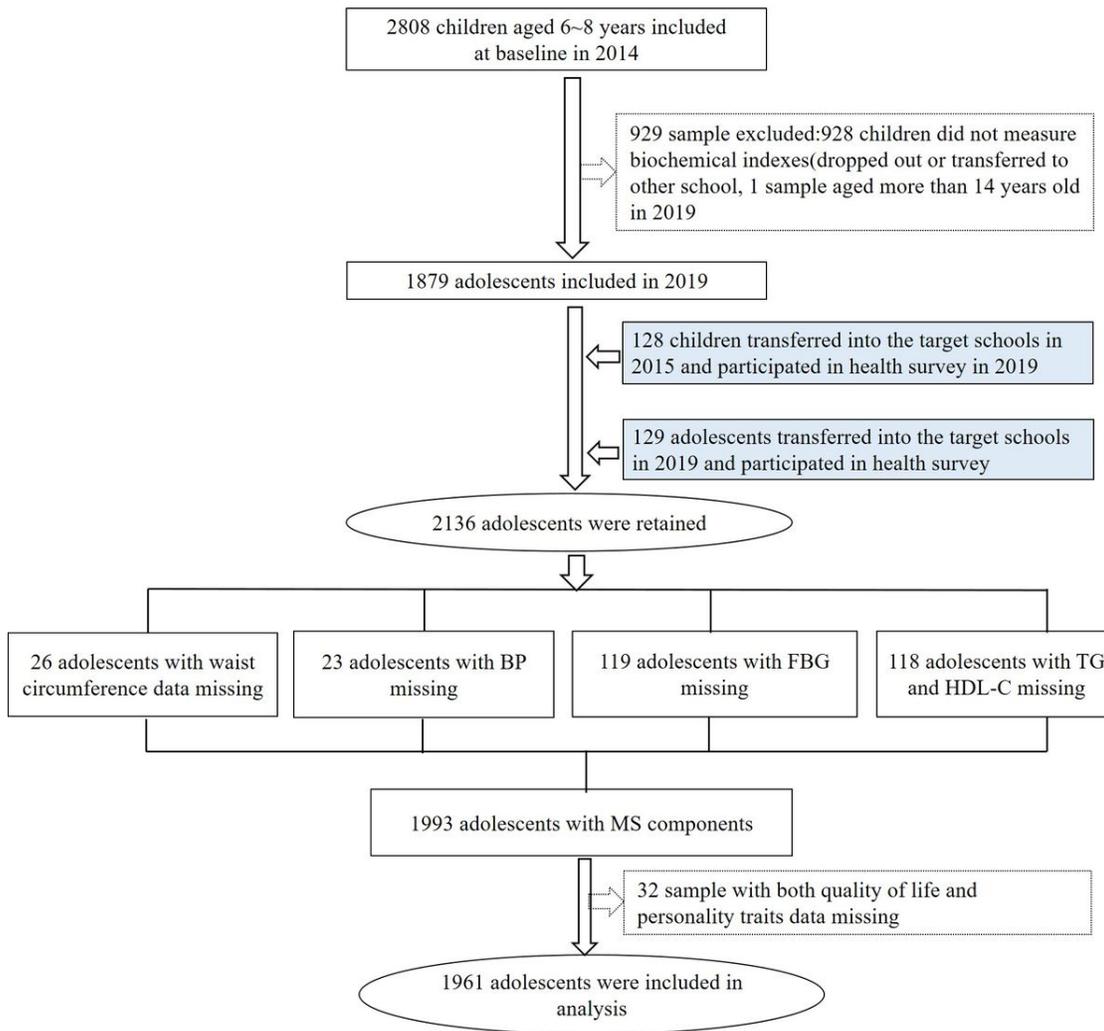


Figure 1

The flow chart of samples been included in the analyses

Supplementary Files

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