

Relationship between multiple lifestyle behaviors and health-related quality of life among elderly individuals with prediabetes in rural communities in China

A STROBE-compliant article

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Abstract

Evidence of the effect of lifestyle behaviors on health-related quality of life (HRQoL) is scarce or ambiguous. The objective of the present study was to explore the associations between multiple lifestyle behaviors and HRQoL among the elderly individuals with prediabetes.

Four hundred thirty-four elderly individuals with prediabetes were included in this cross-sectional study. The Medical Outcomes Study 36-Item Short Form Health Survey Questionnaire (SF-36) was used to assess HRQoL. Multiple lifestyle behaviors, including smoking, alcohol consumption, physical activity, dietary habits, daily sedentary time and sleep duration were self-reported. The associations between HRQoL and multiple lifestyle behaviors were examined using a multivariate linear regression analysis.

Lower-risk physical activities ($\beta=3.19$, 95% CI: 1.32, 5.64), dietary habits ($\beta=2.60$, 95% CI: 1.50, 4.72), and sedentary time ($\beta=2.49$, 95% CI: 1.21, 4.81) were positively associated with the physical health component score (PCS) for HRQoL. Meanwhile, a lower-risk behavior, such as sleep duration ($\beta=2.64$, 95% CI: 1.77, 4.51), was associated with a higher mental health component score (MCS) for HRQoL after adjusting for socio-demographic factors, chronic diseases, anthropometric data and all other lifestyle behaviors. Engaging in a greater number of lower-risk lifestyle behaviors was positively correlated with a better HRQoL.

Multiple lifestyle behaviors were associated with HRQoL among the elderly individuals with prediabetes in rural areas. These results highlight the need for multiple lifestyle behavioral interventions to maintain and improve HRQoL in the elderly individuals with prediabetes.

Abbreviations: BMI = body mass index, DBP = diastolic blood pressure, HRQoL = health-related quality of life, IFG = impaired fasting glucose, IGT = impaired glucose tolerance, MCS = mental health component score, PCS = physical health component score, SBP = systolic blood pressure, WHR = waist-to-hip ratio.

Keywords: elderly, health-related quality of life, lifestyle behavior, prediabetes

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1. Introduction

Prediabetes is defined as blood glucose concentrations that are higher than normal but do not meet the criterion for diabetes,^[1] which is interpreted as either impaired fasting glucose (IFG) and/or impaired glucose tolerance (IGT). Approximately 148.2 million adults and more than 20% of the elderly population in both urban and rural areas in China have prediabetes.^[2] Moreover, individuals with prediabetes have a higher risk of developing diabetes.^[3] However, individuals with prediabetes may progress to normal plasma glucose levels after participating in lifestyle interventions.^[4,5]

Health-related quality of life (HRQoL) is defined as the perception of overall satisfaction with life and involves measurements of status in the domains of physical and mental health. Moreover, HRQoL has become a fundamental assessment in understanding the health status that predicts mortality and chronic diseases.^[6,7] People who progress to prediabetes or diabetes experience a lower HRQoL than people with normal plasma glucose levels.^[8,9] Thus, more people have recognized the importance of identifying and understanding the factors contributing to a good HRQoL.^[10]

Unhealthy lifestyle habits, such as smoking, physical inactivity, and extreme sleep durations, are associated with all-cause

mortality, cardiovascular disease,^[11,12] psychological stress, depression, and anxiety.^[13,14] A large number of studies has already established associations between unhealthy lifestyle habits, such as insufficient physical activity,^[15] a long sedentary time,^[16] and short sleep duration,^[17] with poorer HRQoL. However, these studies have only examined one or two unhealthy lifestyle behaviors. Although a few studies have explored the relationship between multiple lifestyle behaviors and HRQoL among school-aged children^[18] and patients with type 1 diabetes,^[19] no study in the present literature has investigated this association in a population with prediabetes. Considering that the evidence for the effect of lifestyle behaviors on HRQoL is scarce and relevant research is currently lacking, the objective of the present study was to explore the associations between six indicators of lifestyle behaviors and HRQoL among the elderly individuals with prediabetes in rural areas. It was hoped that the results of this study would provide a sound scientific basis for improving HRQoL in this population.

2. Materials and methods

2.1. Study design and participants

This was a cross-sectional study, whose participants were members of the baseline group of a cluster randomized controlled trial, which began in April 2015 and was conducted in the rural areas of Yiyang City, Hunan Province, China. A multi-stage random sampling method was used to select a sample of elderly individuals with prediabetes. According to the administrative regions of China, two counties of Yiyang City were first selected. Second, four townships were randomly selected within each chosen county. Third, a quarter of rural villages were randomly selected in each chosen township. Finally, all households with elderly individuals in each village were listed. Elderly people who had lived in the village for more than 3 years were allowed to participate in the prediabetes screening. People with diabetes or severe mental or physical diseases were excluded from the screening. The oral glucose tolerance test (OGTT) and the 1999 WHO criteria^[1] for prediabetes were used to distinguish individuals with prediabetes from people with normal plasma glucose levels. Briefly, 2144 elderly individuals from 42 villages participated in the screening programme, and 461 had prediabetes. Twenty-seven elderly individuals with prediabetes were not investigated or refused to participate in the subsequent study for various reasons. Finally, 434 elderly individuals with prediabetes who completed the investigation were included in this study. The design and procedure have been described in detail in a previous study.^[20]

2.2. Ethical statement

The present study was approved by the Medical Ethics Committee of Central South University (CTXY-1520002-7). Besides, all participants were provided written informed consent before participating in the study, and they consented to participate in the study.

2.3. Data collection and measures

2.3.1. General information. Socio-demographic characteristics were collected through a self-administered questionnaire and analyzed by trained investigators. The questionnaire included age, gender (1=female and 2=male), marital status (1=non-married and 2=married), education (1=<1 year, 2=1–6 years,

and 3=6 years or more), a history of hyperglycaemia (0=no and 1=yes), a family history of diabetes (0=no and 1=yes), and the presence of chronic diseases (0=absent and 1=present). Chronic diseases referred to non-communicable diseases, including coronary heart disease, hyperlipidemia, chronic obstructive pulmonary disease, stroke, and other diseases.

The anthropometric measurements included height, weight, blood pressure, waist circumference, and hip circumference. These were assessed using standard tools as described in detail in a previous study.^[20] The body mass index (BMI) was calculated using the formula for weight in kilograms divided by height in square meters, m^2 (kg/m^2), and this was then divided into three categories (1: $<24 kg/m^2$, 2: $24–28 kg/m^2$, 3: $\geq 28 kg/m^2$).^[21] People with a systolic blood pressure $>140 mmHg$ and/or diastolic blood pressure $>90 mmHg$ were identified as hypertensive (0=no and 1=yes).^[22] The waist-to-hip ratio (WHR) was calculated by dividing the waist circumference by the hip circumference. A WHR >0.9 in men and >0.8 in women was defined as a high WHR.

2.3.2. Lifestyle behavior measurements. Smoking status was classified into three categories, non-smoker, ex-smoker, and current smoker. These were self-reported by the participants. In addition, the following classifications were made: a lower-risk group (1=non-smoker or ex-smoker) or a higher-risk group (0=current smoker). Alcohol consumption was evaluated using two questions:

1. do you consume alcohol currently; and
2. the number of alcoholic drinks consumed per day when alcohol was consumed.

These items classified participants into the lower-risk group, if they never consumed alcohol, or drink $\leq 25 g/day$ for males and $\leq 15 g/day$ for females; and the higher-risk group if they reported that they drink more than $25 g/day$ for males and $15 g/day$ for females when alcohol was consumed (1=lower-risk and 0=higher-risk).^[23,24] Physical activities within the past week were assessed using the International Physical Activity Questionnaire Long Version (IPAQ), a valid and reliable measurement for four main domains of physical activities,^[25] with a minimum duration of 10 min per physical activity session. Activities were classified into three levels according to the criteria of the IPAQ: low, moderate, and high. Participants were classified as the higher-risk group if they reported a low level of physical activity (1=high or moderate level and 0=low level). Daily sedentary time in the last 7 days was self-reported and subsequently dichotomized into a lower-risk behavior group (1: $<8 h$) or higher-risk group (0: $\geq 8 h$).^[26] Sleep duration in the last week was self-reported and participants were classified into three categories ($<7 h$ per night, $7–8 h$ per night, and $\geq 8 h$ per night). Based on recommendations for the optimal amount of sleep for the elderly,^[27] participants were dichotomized into a lower-risk group (1= $7–8 h$) or higher-risk group (0= $<7 h$ or $\geq 8 h$). Dietary behavior in the past year were assessed using Questionnaire of the Chinese Nutrition and Health Surveillance,^[28] which covered the frequency and quantity of fruits, vegetables, fish, meat, and other types of foods consumed. Additionally, the Diet Balance Index (DBI-07) was calculated to evaluate the dietary quality.^[29] Participants with a total DBI-07 score ranging from 1 to 29 points were classified into the lower-risk group (1=balanced diet); otherwise, individuals were classified into the higher-risk group (0=unbalanced diet).

2.3.3. HRQoL measurement. The HRQoL was assessed using the Medical Outcomes Study 36-item Short Form Health Survey (SF-36),^[30] which was translated into Chinese and exhibits high reliability and validity in the Chinese elderly population.^[31] The SF-36 contains 36 items grouped into eight main domains that constitute two components. Thus, physical functioning (PF), role-physical (RP), bodily pain (BP), and general health (GH) constitute the physical health component, while vitality (VT), social functioning (SF), role-emotional (RE), and mental health (MH) constitute the mental health component. The eight domains were scored on a scale from 0 to 100 points, indicating the worst to best possible health, respectively. Scores for all domains were further summarized and standardized into the physical health component score (PCS) and the MH component score (MCS) according to a user manual, with higher scores representing a better HRQoL.^[32]

2.4. Statistical analyses

Categorical variables are reported as n (%) and continuous variables are presented as the means \pm SD. Comparison of socio-demographics, anthropometric data, HRQoL, and multiple lifestyle behaviors between male and female were conducted using chi-square test for categorical variables, and student's *t* test for continuous variables. Multivariate linear regression models were used to explore the associations between multiple lifestyle behavior and physical and mental components of HRQoL. In this regard, the strength of the association between high-risk and low-risk groups for each of lifestyle behavior was presented as β coefficient and 95% confidence interval (CI). Also, the relationship between each lifestyle behavior and HRQoL, when adjusted for age, gender, education, marital status, a history of hyperglycemia, a family history of diabetes, presence of chronic disease, BMI, hypertension, and WHR, was examined in model 1. Then, the relationship between each lifestyle behavior and HRQoL, when adjusted for all covariates included in model 1 as well as all other lifestyle behaviors, was examined in model 2. Finally, a multiple linear regression was used to examine the combined effects of the lower-risk lifestyle behavior index on both physical and mental health components of HRQoL, using the lower-risk lifestyle behavior index as a categorical variable, and adjusting for the above stated covariates. The number of lower-risk lifestyle behaviors was summarized as the lower-risk lifestyle behavior index, which was the sum of the number of lower-risk lifestyle behaviors a subject was engaged in. The possible values of this index ranged between 0 and 6 points. These values were classified into three categories, 0–2, 3–4, and 5–6, depending on the distribution of the data. The statistical analyses were conducted in SPSS version 20.0 (SPSS/IBM, Armonk, New York). All statistical tests were two-tailed and $P < .05$ was considered statistically significant.

3. Results

3.1. Characteristics of the study sample

Altogether, 2144 elderly individuals participated in the screening, of which 461 had prediabetes; thus, the prevalence of prediabetes in the total sample was 21.5% (461/2144). However, 27 subjects with prediabetes in this sample refused to participate in this survey for various reasons and, finally, 434 individuals with prediabetes were included in this study. The participants' characteristics are summarized in Table 1. The average age

was 69.4 ± 6.4 years. The majority of participants were female, and a large proportion was married and had completed <6 years of education. A minor proportion of the participants had a family history of diabetes and a history of hyperglycemia. The average BMI and WHR of all participants was 23.7 ± 3.6 kg/m² and 0.93 ± 0.1 , respectively.

Approximately 77.2% of the participants were non-smokers or ex-smokers with lower-risk of alcohol drinking behaviors (77.4%), daily sedentary times (80.9%), sleep durations (58.8%), physical activity (76.3%), and dietary behavior (68.2%). The average lower-risk lifestyle behavior index score was 4.0 ± 1.2 . Furthermore, 46 (10.6%) participants reported <2 lower-risk lifestyle behaviors and 159 (36.6%) participants reported 5 to 6 lower-risk lifestyle behaviors. Participants with prediabetes reported a mean \pm SD PCS of 42.1 ± 10.2 and a mean \pm SD MCS of 46.4 ± 8.9 . The results were shown in Table 1.

3.2. Associations between lifestyle behaviors and HRQoL

According to the multivariate linear regression analysis, adjusted for age, gender, education, marital status, a history of hyperglycaemia, a family history of diabetes, presence of chronic diseases, BMI, hypertension, WHR, and all lifestyle behaviors, lower-risk physical activity ($\beta = 3.19$, 95% CI: 1.32, 5.64), daily sedentary time ($\beta = 2.49$, 95% CI: 1.21, 4.81), and dietary habits ($\beta = 2.60$, 95% CI: 1.50, 4.72) were positively correlated with a higher PCS, while a lower-risk sleep duration ($\beta = 2.64$, 95% CI: 1.77, 4.51) was positively associated with a higher MCS.

Compared to participants engaging in 0 to 2 of lower-risk behaviors, a positive correlation with a better PCS was observed in the participants who engaged in 3 to 4 ($\beta = 3.10$, 95% CI: 1.01, 5.19) and 5 to 6 ($\beta = 5.92$, 95% CI: 2.59, 9.26) of lower-risk lifestyle behaviors. But a better MCS was observed only in participants who engaged in 5 to 6 ($\beta = 3.30$, 95% CI: 1.03, 6.58) of lower-risk lifestyle behaviors. The results are presented in Table 2.

4. Discussion

The purpose of this study was to explore whether the lifestyle habits of smoking, alcohol consumption, daily sedentary time, physical activity, sleep duration, and dietary habits are associated with HRQoL. Lower-risk lifestyle behaviors, including physical activity, dietary habits, and daily sedentary time, were positively correlated with the physical health component of HRQoL, while lower-risk behavior in terms of sleep duration was positively correlated with the MCS component of HRQoL. Moreover, individuals who engaged in a greater number of healthy lifestyle behaviors had an increased likelihood of reporting better HRQoL.

Patients with prediabetes tend to report lower HRQoL than individuals with normal plasma glucose levels.^[33,34] From the public health perspective, older adults with prediabetes should be regarded as a target population for interventions and treatments, considering the high conversion rate of prediabetes to diabetes and the relationship between poor HRQoL and adverse health outcomes.^[35] This study, therefore, provided significant evidence that individuals with a greater number of healthy lifestyle behaviors reported a better HRQoL, consistent with many previous studies. For instance, a study including 242 patients with type 1 diabetes reported an association between the clustering of unhealthy lifestyle habits and reduced HRQoL.^[19]

Table 1
Characteristics of the elderly individuals with prediabetes.

Characteristics	Overall (n=434)	Male (n=180)	Female (n=254)	P
Age (years)	69.4 ± 6.4	69.6 ± 6.3	69.1 ± 6.7	.460
Marital status				.165
Married	312 (71.9)	123 (68.3)	189 (74.4)	
Non-married	122 (28.1)	57 (31.7)	65 (25.6)	
Education				.350
<1 year	81 (18.7)	30 (16.7)	51 (20.1)	
1–5 years	272 (62.6)	120 (66.6)	152 (59.8)	
6 years and above	81 (18.7)	30 (16.7)	51 (20.1)	
History of hyperglycaemia				.582
Yes	28 (6.5)	13 (7.2)	15 (5.9)	
No	406 (93.5)	167 (92.8)	239 (94.1)	
Family history of diabetes				.981
Yes	36 (8.3)	15 (8.3)	21 (8.3)	
No	398 (91.7)	165 (91.7)	233 (91.7)	
Presence of chronic disease				<.001
Present	176 (40.6)	92 (51.1)	84 (33.1)	
Absent	258 (59.4)	88 (48.9)	170 (66.9)	
Blood pressure (mmHg)				
SBP	130.3 ± 19.0	128.3 ± 17.9	131.7 ± 19.7	.073
DBP	83.7 ± 10.8	83.7 ± 11.5	83.6 ± 10.2	.881
Hypertension				.011
Yes	173 (39.9)	59 (32.8)	114 (44.9)	
No	261 (60.1)	121 (67.2)	140 (55.1)	
BMI (kg/m ²)	23.7 ± 3.6	23.4 ± 3.4	24.0 ± 3.8	.094
<24	250 (57.6)	112 (62.2)	138 (54.3)	.096
24–28	129 (29.7)	52 (28.9)	77 (30.3)	
>28	55 (12.7)	16 (8.9)	39 (15.4)	
WHR	0.93 ± 0.1	0.92 ± 0.1	0.93 ± 0.1	.461
High	357 (82.3)	150 (83.3)	207 (81.5)	.622
Normal	77 (17.7)	30 (6.7)	47 (8.5)	
Smoking status				<.001
Higher-risk	99 (22.8)	83 (46.1)	16 (6.3)	
Lower-risk	335 (77.2)	238 (53.9)	97 (93.7)	
Alcohol drinking				.004
Higher-risk	98 (22.6)	53 (29.4)	45 (17.7)	
Lower-risk	336 (77.4)	127 (70.6)	209 (82.3)	
Dietary behavior				.796
Higher-risk	138 (31.8)	56 (31.1)	82 (32.3)	
Lower-risk	296 (68.2)	124 (68.9)	172 (67.7)	
Physical activity				.949
Higher-risk	103 (23.7)	43 (23.9)	60 (23.6)	
Lower-risk	331 (76.3)	137 (76.1)	194 (76.4)	
Daily sedentary time				.061
Higher-risk	83 (19.1)	42 (23.3)	41 (16.1)	
Lower-risk	351 (80.9)	138 (76.7)	213 (83.9)	
Sleep duration				<.001
Higher-risk	179 (41.2)	95 (52.8)	80 (31.5)	
Lower-risk	255 (58.8)	85 (47.2)	174 (68.5)	
Lower-risk lifestyle behavior index*	4.0 ± 1.2	3.5 ± 1.1	4.3 ± 1.2	<.001
0–2	46 (10.6)	28 (15.6)	18 (7.1)	<.001
3–4	229 (52.8)	124 (68.8)	105 (41.3)	
5–6	159 (36.6)	28 (15.6)	131 (51.6)	
HRQoL				
PCS	42.1 ± 10.2	41.1 ± 9.8	42.8 ± 10.4	.193
MCS	46.4 ± 8.9	44.8 ± 8.8	47.5 ± 9.0	.019

BMI = body mass index, DBP = diastolic blood pressure, HRQoL = health-related quality of life, MCS = mental health component score, PCS = physical health component score, SBP = systolic blood pressure, WHR = waist to hip ratio.

* Lower-risk lifestyle behavior index score range from 0 to 6 points.

Another study conducted in a 10,000-step cohort indicated an association between engaging in a large number of poor lifestyle behaviors and a higher prevalence of poor HRQoL.^[36] Furthermore, a longitudinal study revealed that each 5-point

increase in the healthy lifestyle index score at baseline was associated with 1.7- and 2.5-fold higher scores for the change in physical and mental HRQoL components after 2.5 years of follow-up.^[37] Many randomized controlled trials have reported

Table 2
Association between multiple lifestyle behaviors and physical and mental health components of HRQoL.

Lifestyle behavior	Physical health component		Mental health component	
	Model 1	Model 2	Model 1	Model 2
Lower-risk lifestyle behavior index*				
0–2	Reference		Reference	
3–4	3.10 (1.01, 5.19) [†]		1.64 (–0.43, 3.71)	
5–6	5.92 (2.59, 9.26) [‡]		3.30 (1.03, 6.58) [‡]	
Smoking status				
Higher-risk	Reference	Reference	Reference	Reference
Lower-risk	1.14 (–1.37, 3.65)	1.21 (–1.29, 3.71)	1.03 (–1.25, 2.60)	1.01 (–1.46, 2.45)
Alcohol drinking				
Higher-risk	Reference	Reference	Reference	Reference
Lower-risk	2.00 (–0.23, 4.23)	1.92 (–0.30, 4.13)	1.06 (–1.22, 2.10)	0.81 (–1.97, 2.36)
Dietary behavior				
Higher-risk	Reference	Reference	Reference	Reference
Lower-risk	2.65 (1.23, 4.79) [‡]	2.60 (1.50, 4.72) [‡]	1.29 (–0.79, 3.36)	1.07 (–1.00, 3.14)
Physical activity				
Higher-risk	Reference	Reference	Reference	Reference
Lower-risk	3.59 (1.37, 5.80) [‡]	3.19 (1.32, 5.64) [‡]	1.97 (–0.53, 4.82)	1.81 (–0.45, 4.07)
Daily sedentary time				
Higher-risk	Reference	Reference	Reference	Reference
Lower-risk	2.58 (1.09, 4.94) [‡]	2.49 (1.21, 4.81) [‡]	1.09 (–1.31, 3.35)	1.08 (–1.21, 3.37)
Sleep duration				
Higher-risk	Reference	Reference	Reference	Reference
Lower-risk	1.46 (0.54, 3.38) [†]	1.43 (–0.58, 3.43)	3.00 (1.16, 4.85) [‡]	2.64 (1.77, 4.51) [‡]

Data were present as β coefficient value (95% CI).

Model 1 adjusted for age, gender, education, marital status, history of hyperglycaemia, family history of diabetes, presence of chronic disease, BMI, hypertension, and WHR.

Model 2 adjuster factors in Model 1 and all lifestyle behaviors listed in the table.

* Lower-risk behavior index score range from 0 to 6 points. β -Value was obtained after adjusted covariates in Model 1.

[†] $P < .05$.

[‡] $P < .001$.

the utility of comprehensive lifestyle interventions in delaying the progression from prediabetes to diabetes.^[38] These phenomena may result from some type of cluster effect between healthy lifestyle behaviors and HRQoL, and provide new insights into lifestyle interventions to improve quality of life and health outcomes at the population level.^[39]

The findings of an association between physical activity and HRQoL are consistent with other studies, which showed that a sufficient level of physical activity was associated with better physical and mental HRQoL.^[40–42] Specifically, a study conducted among 232 individuals residing in Northern Alberta indicated that participants with prediabetes, who reported adequate physical activity, scored 2.7 points higher on the PCS and 3.0 points higher on the MCS for HRQoL than those who had insufficient physical activity.^[40] Moreover, a systematic review of 31 studies revealed a positive correlation between higher levels of physical activity and better HRQoL, and a dose–response relationship in this regard was also observed in several studies.^[43] However, a bidirectional association between physical activity and HRQoL might exist, as subjects who perceive themselves as having better physical and MH are more likely to participate in a physical activity. In addition, the finding of an association between lower daily sedentary time and good physical health is also consistent with the results of previous research reports.^[36,44] For example, Duncan et al^[36] indicated that people who spent more than 11 h per day sitting were 1.33 times more likely to report poor self-rated health than individuals who spent <8 h sitting per day. Similarly, prolonged sedentary time was associated with significantly lower PF and higher

disability levels.^[44] A potential explanation for these results is that people who report a longer sedentary time appear to be more likely to have lower daily living abilities and chronic conditions,^[45] which exacerbates the poor PF and GH components of HRQoL.^[10] Together with the evidence that physical activity interventions have been successful in increasing HRQoL,^[46] the results of this study reinforce the need for increasing physical activity and reducing sedentary time, which is in line with many national physical activity guidelines of many countries.^[47,48]

Furthermore, there has been an increasing number of epidemiological studies examining the relationship between dietary habits and HRQoL.^[49,50] For example, a systematic review including 15 studies showed that older adults with balanced dietary habits were more likely to report better self-rated health.^[51] Moreover, adherence to healthy dietary habits, such as the Mediterranean diet, was noticeably associated with improvements in at least one of the HRQoL domains.^[51] However, based on the results of this study, lower-risk dietary behaviors were not significantly associated with the mental health component of HRQoL. Nonetheless, many studies have reported that higher fruit and vegetable consumption, and moderate fish consumption were associated with higher scores on mental health.^[52,53] Despite the connections between diet and MH, evidence on the association between dietary behaviors and MH components, such as depression, is mixed^[54–56] and requires further research.

Also, the result of this study regarding the association between sleep duration and MCS component of HRQoL was consistent

with previous findings.^[57,58] For example, a cohort study of 3834 older adults was conducted in Spain and found that participants with extreme sleep durations had lower scores on the physical and mental components of the SF-36 scale.^[59] Another population-based study including 1418 elderly individuals showed that subjects who slept for <6h attained lower SF-36 scores for the vitality and MH components than those who slept for 7 to 8 h.^[60] Additionally, both short- and long-sleep durations increased the risk for dissatisfaction with life and negative emotions.^[61,62] However, based on accumulating evidence, sleep quality, rather than sleep duration, is strongly associated with HRQoL.^[63,64] The mechanism by which sleep quality and sleep duration interact with HRQoL is currently being investigated and further research is needed to ascertain these interactions.

This study has several limitations. First, causal and effect relationships could not be established due to the cross-sectional design. It is possible that having good physical health and mental health may enhance engagement in more low-risk lifestyle behaviors, and this might have influenced the findings of this study. Secondly, lifestyle behaviors and HRQoL were self-reported, hence, these measurements may not be accurate, which may underestimate or overestimate the investigated outcomes. Also, self-administered questionnaires were used to assess some experiences of the participants 1 month or 1 year before the start of this investigation. Therefore, recall bias was unavoidable. Thirdly, information may be lost due to dichotomization of the measurements of lifestyle behavior, which limited the ability to examine dose–response relationships between lifestyle behavior and HRQoL. Moreover, every type of lifestyle behavior was equally weighted and contributed to the lower-risk lifestyle behavior index. This combined effect may not be accurate given the different β coefficients for each lifestyle behavior on HRQoL, and limited categories of the lower-risk lifestyle behavior index in this study. Finally, this study was conducted in the rural areas of one City in Hunan province in China. Therefore, the generalization of the results of this study to other populations should be carefully considered. Given these limitations, further cohort and longitudinal studies should be conducted to obtain a better understanding of the associations between multiple lifestyle behaviors and HRQoL.

5. Conclusions

In summary, lower-risk lifestyle behaviors were associated with both the physical and MH components of HRQoL among the elderly individuals with prediabetes in the rural areas of Yiyang City in China. Moreover, the participants with prediabetes, who engaged in a greater number of lower-risk lifestyle behaviors, were more likely to have a better HRQoL.

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