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Original Research

Relationship between Perceived Social Support and Sleep Quality among Older Men in Guangdong Province, China: The Mediating Role of Rumination and the Moderating Role of Physical Activity

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Abstract

Background: The mental health status of older men is affected by several factors. Perceived social support, rumination, sleep quality, and physical activity are key factors that affect the mental health status of men over 60 years old. The mechanisms of their interactions have not been fully elucidated. The purpose of this research was to explore the relationship and interaction mechanisms among perceived social support, rumination, physical activity and sleep quality. The differences in physical activity levels of individuals in different characteristics groups were also investigated. **Methods**: A total of 296 valid questionnaires were collected and the participants had a mean age of 69.94 ± 7.97. The Perceived Social Support (PSS), Ruminative Responses Scale (RRS), Pittsburgh Sleep Quality Index (PSQI), and the International Physical Activity Questionnaire (IPAQ) were administered to older men in Guangdong Province over 60 years old to collect data on perceived social support, rumination, physical activity and sleep quality. The established hypotheses were tested using mediation model and moderation model. The mediating effect of rumination between perceived social support and sleep quality and the moderating effect of physical activity between perceived social support and sleep quality were examined. **Results**: (1) The findings showed that the levels of physical activity varied significantly based on characteristics variables such as age, perceived age, residence, and amount of housework undertaken. (2) Perceived social support was negatively correlated with rumination and poor sleep quality, and rumination was positively correlated with poor sleep quality. (3) Rumination partially mediated the relationship between perceived social support and sleep quality, with a mediating effect of 36.9%. (4) Physical activity moderated the relationship between perceived social support and sleep quality, with a significant moderating effect observed for moderate-high intensity physical activity compared with low intensity physical activity. **Conclusions**: Older men who perceived social support reduced rumination level and improved sleep quality. Moderate-high physical activity positively modulated the relationship between perceived social support and sleep quality more effectively than low physical activity level. The present findings can be used to establish recommendations and measures to improve the mental health of older men.

Keywords: older men; perceived social support; rumination; sleep quality; physical activity

1. Introduction

China's older population has significantly increased in the recent past. The results of the seventh national census indicate that the population aged 60 and above in mainland China as of November 1, 2020, was 264,018,766, accounting for 18.70% of the total population. Notably, 19,063,528 people were aged 65 and above in 2020, accounting for 13.50% of the total population in the country. China has one of the fastest aging populations globally and is currently referred to as an aging society [1]. Physical and mental health disorders among older adults have markedly increased in the recent past despite the country's rapid economic development, improved living standards, and higher per-capita life expectancy. More than 1 million of China's older adults [2] were diagnosed with at least one chronic non-communicable disease in 2013 [3]. Previous findings show that several thousand were diagnosed with multiple chronic diseases comorbidity in 2013. The number of people diagnosed with chronic (non-communicable) such as ischemic heart disease, cancer, stroke, arthritis, and dementia, among older adults increases with the increase in age [4].

In addition to chronic physical illnesses, older adults in China also experience greater mental illness. For example, the detection rate of depressive symptoms in older adults over 60 years old was 32.55%, with older men accounting for 13.58% [5]. Besides, a previous meta-analysis of older adults in China showed that the prevalence of suicidal ideation among older adults in China ranged from 1.00% to 26.01%, with a prevalence of 9.75% [95% CI (6.53%, 13.52%)] in males [6]. The physical and mental health disorders of older adults are a major public health concern. Previous studies report that various psychological factors such as rumination, perceived social support,

and sleep quality are correlated with depression incidence in older adults [7–9]. Several studies report that active physical activity effectively mediates the morbidity and mortality of cardiovascular diseases and ameliorates chronic physical diseases [10–12], as well as increases life expectancy thus improving mental health [13]. The Global Strategy on Diet, Physical Activity and Health proposed by WHO [14] and the 2010 General Health Guidelines developed by the US Department of Health and Human Services indicate that physical activity plays an essential role in promoting health [15]. The purpose of the present study was to explore the role of rumination and physical activity on the interaction between perceived social support and sleep quality among older adults.

1.1 Perceived Social Support and Sleep Quality

Sleep is a basic human need, and it markedly affects health. Sleep quality is a multidimensional concept that comprises sleep duration, sleep efficiency and sleep disorders. It represents the sleep status of an individual and is an important indicator of an individual's health status. Some changes in sleep status occur during aging, both at the macro-level (such as sleep duration and sleep stages) and at the micro-level (such as quantity and quality of sleep oscillations) [16]. The quality of sleep in older adults is implicated in modulating cognitive function [17,18], and is associated with long-term risk of developing cancer [19], depression and anxiety [20], and modulates the quality of life [21].

Some scholars in China recently explored the prevalence of sleep disorders in older adults through a meta-analysis. The findings showed that nearly half of the Chinese older people over the age of 60 who enrolled in the study between 2000 and 2013 had poor sleep quality. The prevalence of sleep disorders was 47.2% (95% CI: 35.8%–58.5%), with the prevalence in older women (58.2%) being higher compared with that of older men (49.2%) [22]. Notably, the results showed that prevalence increased with an increase in age. In addition, previous findings show that one-third of community-dwelling older adults in China have poor sleep quality, with difficulty in maintaining sleep as the most common manifestation, followed by difficulty in falling asleep and easy early awakening [23].

Social support refers to the support activities that individuals receive from their social relationships [24]. Perceived social support refers to an individual's subjective beliefs and expectations about how much social support they can receive from their social relationships and interpersonal interactions and the quality of that support [25]. Perceived social support is correlated with actual social support and reflects the social support that individuals perceive can be provided by the people around them when they are under stress in their lives.

Perceived social support is an important social factor that affects sleep quality. A US study on the relationship between perceived social support and sleep quality during the COVID-19 pandemic showed that individuals with high levels of perceived social support had a 52% lower risk of having poor sleep quality (OR = 0.48 [95% CI: 0.26–0.88]) compared with subjects with low levels of perceived social support [26]. The effects of stress on sleep are alleviated when individuals perceive that they are receiving support from others, which ultimately improves sleep quality [27]. Studies on older adults showed that subjective perceived social support is significantly negatively associated with sleep quality [28]. Moreover, perceived social support is a significant negative predictor of sleep status.

In summary, from these findings we hypothesized that: perceived social support is significantly negatively correlated with sleep quality (H1).

1.2 The Mediating Role of Rumination

Rumination is a negative cognitive aspect whereby individuals direct their sustained attention to the behavior and thought of their current status and repeatedly reflect on the emotion and its possible causes and consequence without adopting active problem-solving strategies [29]. For example, when people experience setbacks and failures in daily life, they can be considered to have ruminations if they tend to repeatedly think about the cause of these setbacks or if they dwell on emotions such as "I am very sad" and cannot get rid of the effects of the event for a long time.

The cognitive model of insomnia states that excessively negative cognitive activity of an individual is the first link to insomnia [30]. Individuals repeatedly engage in negative thinking when they engage in ruminative thinking, which can trigger spontaneous arousal and cause emotional distress in individuals, ultimately affecting sleep quality [30,31]. Several previous studies report that college students with high levels of rumination have poorer sleep quality compared with those with low levels of rumination [32–34]. Notably, the effect of perceived social support and rumination on sleep quality have not been fully elucidated. Ying Song *et al*. [35] reported that company workers' perceived social support was significantly negatively correlated with their ruminative thinking. This implies that a low level of perceived social support for an individual is associated with increased ruminative thinking. However, findings from a study conducted by Boren [36] on workers showed that a high level of perceived social support of individuals was associated with a high level of rumination among the workers. Marini *et al*. [37] conducted a study on older people and the findings showed that perceived social support for spouses was not significantly associated with rumination, and perceived social support for family members or friends was not significantly correlated with rumination.

Based on these findings, we hypothesized that: rumination mediates the relationship between perceived social support and sleep quality (H2).

1.3 Moderating Effect of Physical Activity

World Health Organization defines physical activity as any physical exercise produced by skeletal muscle that requires energy expenditure, including activities performed during leisure time, driving transportation, and work. Notably, the previous finding indicates that moderate and high-intensity physical activity improves an individual's health [38]. Physical activity is quite crucial for older people. Findings from previous studies indicate that the physical activity levels of Chinese older people are significantly associated with their physical and mental health [39]. The risk of cardiovascular disease is reduced, and abilities such as flexibility, balance, and maximal muscle strength are restored when older people engage in regular physical activity [40]. Several empirical studies show that physical activity positively affects on sleep quality in the older [41–43]. A systematic review also shows that exercise programs have multiple positive effects on sleep in generally healthy older adults [44]. In addition, regular physical activity is a psychotherapeutic approach used to alleviate depressive symptoms and improve the quality of life of older adults [45].

Chogahara *et al*. [46] conducted a review which found that social support is one of the social factors that was positively associated with commitment to physical activity participation and intention to be physically active. An empirical study shows that perceived social support had a significantly positive effect on physical activity in older South Koreans [47].

From these findings, we hypothesized that: physical activity plays a moderating role in the relationship between perceived social support and sleep quality (H3).

2. Materials and Methods

2.1 Participants

Trained research assistants distributed the questionnaires to the older males at Changgang Campus of Guangzhou University for the Elderly and Xiatang Campus of Guangdong University for the Elderly for face-to-face data collection. The assistants explained the questions of the questionnaire and guided older adults in completing the questionnaire. The questionnaires were collected after in the participants filled them. In addition, trained social workers distributed questionnaires to several urban and rural older adults senior centers in Guangdong Province. Moreover, trained university students who are living in various parts of Guangdong province (most of them live in rural areas) took the questionnaires home to be completed by their grandfathers according to unified requirements. The subjects were informed in advance that should voluntarily participate in the survey and were allowed to withdraw voluntarily. Participants were not paid for participation in this study. A total of 331 questionnaires were collected in this study and 35 invalid questionnaires were discarded. The inclusion criteria of the subjects were as follows: (1) subjects aged 60 or older; (2) male subjects; (3) personnel that have agreed to voluntarily participate in the study with informed consent; (4) subjects with no previous mental illness. The results showed that the age of the males included in the ranged from 60 to 93 years with a mean age of 69.94 (SD = 7.97). Data on other characteristics are presented in Table 1.

2.2 Instruments

2.2.1 Perceived Social Support (PSS)

The perceived social support scale was developed by Zimet *et al*. [48], and comprises 3 dimensions of family support, friend support and other support, and a total of 12 items. The scale uses a 7-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (7) (for instance "I get the emotional help and support I need from my family"). The total score is obtained from the sum of the score of each item. Higher scores indicate more perceived social support. The English version of the scale was translated to the Chinese version and revised by Li Huang, Ganjin Jiang and Weihong Ren in 1996 [49]. Previous studies report that the Cronbach's α of the Chinese version of the scale is greater than 0.8 [50,51], indicating that it is highly reliable and has good validity. This implies that it can be accurately used to evaluate perceived social support of individuals. The Cronbach's α of the original scale was 0.88, and the Cronbach 's α in this study was 0.95.

2.2.2 Ruminative Responses Scale (RRS)

The ruminative responses scale was developed by Nolen-Hoeksema and comprises 3 dimensions including reflection, brooding and depression-related, with a total of 22 items [52]. The scale uses a 4-point Likert scale ranging from "never" (1) to "always" (4) (for instance "I often think that if this feeling persists, I can't concentrate"). The total score is obtained from the sum of the score for each item. High points on the scale indicate high rumination. The original version of the scale had good reliability and high validity. The original version was translated to the Chinese version and revised by Xiu Han and Hongfei Yang in 2009 [53]. The SCL-90 depression and anxiety subscales, self-esteem scales and life satisfaction questionnaires were selected to test the validity of the Chinese version. The Cronbach's α of the Chinese version was 0.90 and the retest reliability was 0.82. This indicated that the Chinese version has good reliability and validity and can be used in studies [53]. The Cronbach's α in this study was 0.95.

2.2.3 Pittsburgh Sleep Quality Index (PSQI)

The Pittsburgh Sleep Quality Index (PSQI) was developed by Buysse and comprises 19 self-assessment and 5 other-assessment items. The 19th and 5 other-assessment items in this scale are not used during scoring [54]. In the present study, 18 self-assessment items were included in the scoring, comprising 7 components as follows: sleep qual-

Table 1. Study participant characteristics (n = 296).

Variables	Categories	N (%); M ± SD
Age		69.94 ± 7.97; 60–93
Gender		
	Male	296 (100.0)
Living place		
	Rural	72 (24.3)
	Urban	224 (75.7)
Living status		
	Living alone	36 (12.2)
	Cohabiting with spouse	146 (49.3)
	Live with children	44 (14.9)
	Living with a spouse in a child's home	32 (10.8)
	Living with children and grandchildren in an extended family	38 (12.8)
Education		
	Primary school or below	84 (28.4)
	Junior/high school	90 (30.4)
	College/secondary school level	66 (22.3)
	Bachelor's degree or above	56 (18.9)
Income		
	Below 800	6 (2.0)
	800–1600	28 (9.5)
	1700–2500	30 (10.1)
	2500–5000	66 (22.3)
	5000–8000	62 (20.9)
	8000–10000	26 (8.8)
	More than 10000	18 (6.1)
	Refused to answer	60 (20.3)
Frequency of interaction with children		
	Frequent contacts	236 (79.7)
	No contact without necessity	50 (16.9)
	Rarely or never	10 (3.4)
Perceived age		
	10 years younger	46 (15.5)
	5–10 years younger	66 (22.3)
	0–5 years younger	42 (14.2)
	same	100 (33.8)
	0–5 years older	30 (10.1)
	5–10 years older	12 (4.1)
Level of housework undertaken		
	0–25%	114 (38.5)
	25%–50%	132 (44.6)
	50%–75%	40 (13.5)
	75%–100%	10 (3.4)
Interpersonal relationship		
	Very satisfied	58 (19.6)
	Satisfied	128 (43.2)
	Passable	96 (32.4)
	Dissatisfied	12 (4.1)
	Very dissatisfied	2 (0.7)

M, Mean; SD, Standard Deviation.

ity, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleeping medication, and daytime dysfunction. The items were scored on a 0–3 scale (for instance "During the past month, how would you rate your sleep quality overall?"). The total score is obtained by summing the scores for all components. High scores indicate poor sleep quality. The original version of the scale was translated to the Chinese version and revised by Xianchen Liu *et al*. in 1996 [55]. A total of 112 normal adults, 560 college students, 45 cases of insomnia, 39 cases of depression and 37 cases of neurosis were enrolled in the previous study to verify the psychometric quality of the Chinese version [55]. The scale has also been used in several studies in China. The Cronbach's α of the PSQI scale is 0.84, and the retest reliability is 0.81 [55]. The Cronbach's α of the original scale was 0.83, and the Cronbach's α in this study was 0.86.

2.2.4 International Physical Activity Questionnaire (IPAQ)

The International Physical Activity Questionnaire (IPAQ) was developed by the International Consensus Group on Physical Activity Measurement. It is grouped into two: a long form version (occupation, housework, transportation, leisure, 4 categories of physical activity and sedentary activity) and short form version (7 questions) [56]. In the current study, the short form version was used to evaluate the one-week frequency and daily cumulative time of low-intensity, moderate-intensity and high-intensity activities in the last week. The Metabolic Equivalent Intensity (MET) levels were then calculated as follows: physical activity in one week (cal/week) = physical activity at work (cal/week) + physical activity in transportation (cal/week) + physical activity in housework (cal/week) + recreational physical activity (cal/week), daily physical activity (cal/day) = weekly physical activity (cal/week)/7 [57]. The participants in this study were assigned into three age groups: 60–69, 70–79, and above 80. According to the physical activity, in the different age groups, the groups were further divided into the low physical activity group (subjects with a mean less than or equal to 50%), the middle physical activity group (subjects with an average greater than 50% and less than 150%), and the high physical activity group (participants with a mean value greater than or equal to 150%) [58]. The housework undertaken by older men was included as the physical activity item according to the cultural characteristics of China, and converted to the MET. There are 120 participants in low level group, 140 participants in middle level group and 36 participants in high level group. Hence, we combined the high group into the middle group and named middle-high group. The reliability and validity coefficients of the Chinese version of the questionnaire were both greater than 0.6, indicating the version was highly reliable and valid [59].

2.3 Procedures

Data were collected from January 1, 2021 to April 30, 2022. Participants filled out an informed and free consent form before participation in the study. The subjects were informed that their participation was voluntary and were allow to withdraw from the study at any time. Participants took 10–20 minutes to complete the questionnaire independently after guidance. The investigation process followed the principle of confidentiality.

2.4 Statistical Analysis

Quantitative data were analyzed using IBM SPSS ® (Statistical Package for the Social Sciences), version 26.0 (IBM Corp, Armonk, NY, USA). Descriptive analyses were performed by calculating frequencies and percentages. Pearson correlation analysis was then conducted to explore the relationship between variables. Six characteristics variables including age, education, perceived age, frequency of contact with children, living place, and amount of housework undertaken were selected for analysis of variance to explore the differences in physical activity. The Model 4 of the PROCESS macro for SPSS was used to evaluate the mediating effect of rumination [60]. Further, Model 1 of the PROCESS macro for SPSS was used to evaluate the moderating effect of physical activity. The significance test of the mediating effect and moderating effect was tested by the bootstrapping method. The bootstrap confidence intervals (CIs) determine whether the effects in Model 4 and 1 are significant, based on 5000 random samples, and the upper and lower of the CIs are present in the table. The model is regarded significant if the confidence interval of the mediation model and the moderation model does not contain 0 [60].

3. Results

3.1 Correlations between Variables

The results of correlation analysis are presented in Table 2. The findings showed that perceived social support was significantly negatively correlated with sleep quality ($r = –0.340$, $p < 0.01$) and rumination ($r = –0.341$, $p < 0.01$). A significant positive correlation was observed between sleep quality and rumination ($r = 0.441$, $p < 0.01$).

3.2 Differences in Physical Activity according to Age, Education, Perceived Age, Frequency of Contact with Children, Living Place, and Amount of Housework Undertaken

Results of the difference analysis are shown in Table 3. The findings showed significant differences in physical activity among the groups based on age, perceived age, living place, and the amount of housework undertaken. Physical activity levels of participants aged 60–69 years were significantly higher relative to those of participants aged 70–79 and above 80 years. Physical activity levels of subjects aged 70–79 years were not significantly different from those of

Table 2. Correlations between variables.

Variable	*M*	*SD*	1	2	3
1. Perceived social support	61.243	14.171	—		
2. Sleep quality	6.770	3.616	–0.340 **	—	
3. Rumination	39.298	11.008	–0.341 **	0.441 **	—

** $p < 0.01$.

participants aged above 80 years. Subjects who perceived themselves to be more than 10 years younger than their actual age and participants who perceived themselves to be 5–10 years younger had significantly higher levels of physical activity compared with those who perceived themselves as 0–5 years younger, and there was no significant difference in the other groups. The physical activity level of urban men was significantly higher relative to that of rural men. The results showed that the physical activity level of older men who undertook 25%–50% of housework was significantly higher compared with that of older men who undertook 0–25%. Analysis showed no significant difference in physical activity among the other groups.

3.3 Rumination Mediates the Relationship between Perceived Social Support and Sleep Quality

Model 4 of the PROCESS macro of SPSS was used to evaluate the mediation effect [60]. The findings showed that perceived social support significantly predicts rumination ($\beta = –0.376$, t = –6.21, $p < 0.001$). Notably, perceived social support significantly predicts sleep quality ($\beta = –0.339$, t = –6.20, $p < 0.001$). And rumination significantly predicts sleep quality ($\beta = 0.333$, t = 6.78, $p < 0.001$). The findings indicated that rumination is a partial mediator between perceived social support and sleep quality (Indirect effect = –0.125, SE = 0.036, 95% CI (–0.205, –0.063)), and the mediating effect accounted for 36.9% of the total effect of perceived social support to sleep quality (Fig. 1 and Table 4).

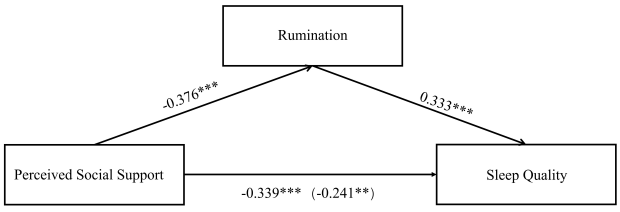

Fig. 1. The mediating role of rumination on sleep quality and perceived social support. *** $p < 0.001$.

3.4 Physical Activity has a Significant Moderating Effect on the Relationship between Perceived Social Support and Sleep Quality

Model 1 of the PROCESS macro of SPSS was used to evaluate the moderating effect of physical activity on the relationship between perceived support and sleep quality [60]. The results showed that perceived social support × physical activity interaction was negatively and significantly related to poor sleep quality ($\beta = –0.068$, $p < 0.05$), with a conditional effect size of 0.01. Lower sleep quality scores represented better effect. This finding implies that middle-high physical activity levels ($\beta = –0.121$, $p < 0.001$) and low physical activity levels ($\beta = –0.052$, $p < 0.05$) positively modulated the relationship between perceived social support and sleep quality. Higher sleep quality scores represented worse sleep quality levels. This implies that the positive impact of perceived social support on sleep quality was significantly increased when the level of physical activity was higher. In particular, middle-high levels of physical activity had a stronger moderating effect than low levels of physical activity (Fig. 2).

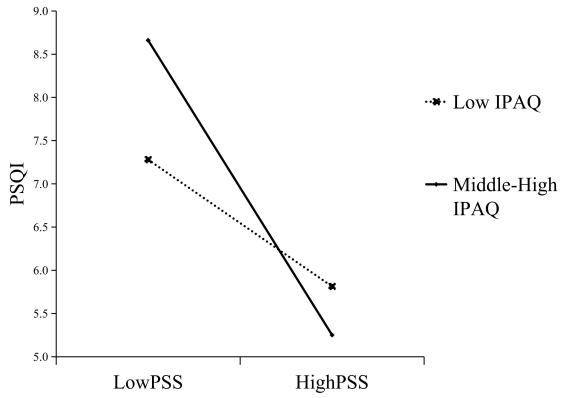

Fig. 2. Moderating role of IPAQ on the relationship between perceived social support and sleep quality.

4. Discussion

Only few studies have explored the relationship between perceived social support and sleep quality in older men. In addition, the mediating mechanisms underlying this relationship have not been fully elucidated. The predictive role of perceived social support on sleep quality in older men, the mediating role of rumination on this relationship, and the moderating role of physical activity on the relationship were explored in the present study. The results indicated that perceived social support is negatively correlated with poor sleep quality, and the relationship between perceived social support and sleep quality is mediated by physical activity.

Table 3. Physical activity of participants in different characteristics groups.

Variable	Categories	Physical activities		F	p	n_{p^2}
		M	SD			
Age group				5.55	0.004	0.04
	60–69	1722.65	1412.94			
	70–79	1172.84	1644.34			
	Above 80	1109.87	1113.61			
Education				1.62	0.186	0.02
	Primary school or below	1304.91	1469.85			
	Junior/high school	1255.72	1263.68			
	College/secondary school	1725.04	1647.99			
	Bachelor's degree or above	1557.31	1630.90			
Perceived age				4.45	0.001	0.07
	10 years younger	2145.42	2272.21			
	5–10 years younger	1740.71	1497.96			
	0–5 years younger	961.50	634.13			
	Same	1162.93	1320.52			
	0–5 years older	1242.01	1060.61			
	5–10 years older	1348.00	832.83			
Frequency of interaction with children				1.85	0.159	0.01
	Frequent contacts	1401.84	1513.47			
	No contact without necessity	1701.85	1436.62			
	Rarely or never	776.10	905.91			
Living place				14.34	<0.001	0.05
	Rural	865.54	1248.86			
	Urban	1613.26	1517.86			
Level of housework undertaken				5.14	0.002	0.05
	0–25%	1014.48	1281.71			
	25%–50%	1697.39	1655.12			
	50%–75%	1624.95	1348.08			
	75%–100%	1898.35	866.41			

M, Mean; SD, Standard Deviation.

Table 4. Testing the pathways of the mediation model.

Effect	β	BCa 95% CI	
		Lower	Upper
Direct effects			
PSS→PSQI	–0.339***	–0.446	–0.231
PSS→RRS	–0.376***	–0.495	–0.257
RRS→PSQI	0.333***	0.236	0.430
Indirect effect			
PSS→RRS→PSQI	–0.125	–0.205	–0.063

PSS, Perceived Social Support; PSQI, Pittsburgh Sleep Quality Index; RRS, Ruminative Responses Scale.

***$p < 0.001$.

4.1 Perceived Social Support, Rumination and Sleep Quality are Correlated

The level of perceived social support in older men had a significant negative predictive effect on their rumination and poor sleep quality. The results indicated that perceived social support is a protective factor that improves sleep quality and alleviates psychological distress in older men. These findings are consistent with results from a previous study [8]. Perceived social support improves the health status and prolongs the lifespan of a person by modulating the body's internal immune function. People with high level of perceived social support can establish good social relationships with others, and the level of the inflammatory factor IL-6 is low in these individuals [61]. Perceived social support allows people to get the support of family and friends, thereby enhancing their well-being and improving sleep quality of individuals. Approximately 45.5% of the Chinese population have poor sleep patterns, with the older people accounting for 56.7% of this population [20]. Incidence of sleep disorders in older adults increases due to retirement, living alone, declining health status, widowhood and other age-related events. Some scholars studied the sleep quality of European older adults and reported that the prevalence of disorders of sleep ranged from 16.6% to 31.2%, and sleep quality was highly associated with mental illness [62]. A study on sleep quality and psychological factors among Japanese older people reported that the sleep quality of older adults was significantly correlated with de-

pression [63]. Previous findings showed that the risk of depression in older adults is significantly higher compared with that of non-sleep disorder group. The main manifestation in 90% of depression patients is sleep disorder [6]. Therefore, the present findings provide an understanding of the factors that positively affect sleep quality among older adults. In addition, these findings can be used to promote attention to social support and psychological factors as interventional measures for alleviating sleep disorders among older men.

The study findings showed that rumination was positively correlated with poor sleep quality, and rumination significantly and positively predicted poor sleep quality, which is consistent with findings from previous studies [64,65]. The continuous cognition hypothesis proposed by Brosschot *et al*. [66] states that rumination causes persistent psychological and physical arousal in individuals, which in turn result in short-term or long-term sleep disorders. The 3-P model theory of insomnia states that rumination leads to poor sleep patterns [67]. Various predisposing factors in life such as stressful events, susceptibility factors such as cognitive style, maintenance factors such as wrong cognition, promote the occurrence of negative emotions such as depression and anxiety. Rumination is a cognitive style that continuously stimulates the high arousal state of the brain, resulting in sleep disorders and blocking the sleep maintenance activities of an individual. This implies a reduction of rumination in old men and improving their ability to perceive social support can help them be active as well as improve their sleep quality. These findings confirm our first hypothesis.

4.2 The Mediating Role of Rumination

The present findings showed that perception of social support in older men had direct and indirect effects on sleep quality. Perceived social support improves the sleep quality of older men by reducing rumination.

There are several possible mechanisms to explain this relationship: first, the principle of the main-effect model of perceived social support states that increase in perceived social support improves the overall mental health level of an individual [68]. Older men with higher perceived social support have higher frequency of positive emotional experiences, which helps in alleviating irrational beliefs and reduces the amount of time that negative events are repeatedly processed in their minds, resulting in less rumination. On the contrary, older men with lower experience of social support have increased negative emotions resulting in more irrational beliefs and higher rumination. Individuals experiencing more social negative events pay more attention to others who cannot provide social support, thus they fail to understand the support from society, which enhances rumination thinking. This result is consistent with findings from previous research [69]. The findings of the current study indicate that a more severe the rumination tendency is associated with poor sleep quality similar to findings from previous studies [70]. Some insomniacs have high rumination tendency and take longer to fall asleep, report more sleep disorders, and have poor subjective sleep quality compared with subjects with low rumination tendency. Rumination prompts individuals to focus on their negative emotions and behaviors, promoting the negative effects of the negative emotions. Previous studies report that individuals with negative emotions repeatedly think about the negative emotions and their causes [17] resulting in excessive brain activity and sleep disorders. Findings from stress-buffering models of social support [69] indicate that social support moderates the internal and external environment pressure experienced by older men due to functional decline, illness and death of relatives. In addition, social support alleviates anxiety and depression in older men thereby reducing rumination and protects older men from the effects of stress. Older men with high perceptions of social support easily disclose their unpleasant emotions and distress to family and friends. The sharing and support reduce the adverse effects of stressful events, and alleviate stress by increasing a sense of control over stress [24]. Moreover, friends and relatives provide several resources, experience and information to overcome the negative emotions. In addition, they help these subjects to explore strategies and methods to solve the problems, thus reducing rumination caused by stressful events. This helps older men to adjust to activities to beneficial physical and mental health, alleviates the stress response symptoms, and improves their sleep quality. These findings confirm our second hypothesis.

4.3 Moderating Effect of Physical Activity

The findings of the present study showed that the physical activity levels of those who perceived themselves as younger than their actual age by more than 10 years and by 5–10 years were significantly higher relative to the physical activity levels of subjects who perceived themselves as 0–5 years younger. The physical activity level of older men living in urban areas was significantly higher compared with that living in the rural areas. Men who undertook 25%–50% housework had significantly higher levels of physical activity compared with men who undertook 0–25% housework. Guangdong is a relatively wealthy Chinese province that adheres to traditional culture. The older residents have high social status and good living conditions, and a healthy life and long lifespan. The findings of the current study indicated that older people with a younger mental age are more actively involved in various physical activities. Notably, the educational level of older men living in cities was higher relative to that of older men living in rural areas. This explains why older men living in urban areas pay more attention to physical health care compared with men living in rural areas. Urban communities have more advanced sports activities and have effective transportation facilities. Therefore, older men have more opportunities

for participating in various sports activities. Women are mainly engaged in housework in Chinese traditional culture, whereas men only perform auxiliary roles in housework. The results of the present study showed that older men mainly participated in moderate housework, which allows them to spend more time going out with friends for leisure and sports activities.

Further, the role of physical activity on the relationship between perceived social support and sleep quality was explored in the present study. The findings showed that physical activity positively moderated the relationship between perceived social support and sleep quality. Physical activity in older men significantly enhanced the effect of perceived social support on sleep quality. Those with lower levels of perceived social support had poor sleep quality, whereas higher levels of perceived social support were associated with better sleep quality. Moderate-intensity and high-intensity physical activity exhibited higher moderating effect compared with low-intensity physical activity. This finding shows that moderate to high-intensity physical activity positively modulates the relationship between perceived social support and improved sleep quality.

This effect can be attributed to the fact that most older men are more enthusiastic about physical activity, they frequently participate in physical activities, and regularly engage in physical activities [71]. In addition, moderate-to-high-intensity aerobic exercise improves sleep quality, which can reduce the scores of the dimensions of Pittsburgh's sleep quality scale. Further, moderate-to-high-intensity exercise reduces various physiological and psychological stress caused by poor sleep quality [72,73]. People consume part of their physical strength by participating in aerobic exercise and fatigue is induced, thereby inhibiting secretion of excitatory substances in the brain, which ultimately promotes good sleep quality. Physical activity improves sleep quality, and relieves physical fatigue, thus improving physical and mental health [74]. Long-term physical activity of a certain intensity can improve the physical function of older adults [75]. In addition, long-term physical activity reduces disease incidence and slows the aging process. Active physical activity promotes the well-being of older adults [76]. Well-being significantly affects perception of social support, and the impact increases with increase in age [77]. People with higher levels of well-being easily explore supportive resources and perceive the actions of other people as supportive. These findings indicate that a certain intensity of physical activity enhances the mental health of older adults [73]. Good mental health in older adults can be achieved through participation in physical activities and exercise [78]. These findings confirm hypothesis 3.

4.4 Limitations of the Study and Future Directions

Some limitations of the study should be considered when interpreting the results. First, data were mainly collected through self-report by older males in this study. This is subject to common method biases, and Harman's one-factor test should be used to determine the variance of the measurement items [79]. If a single factor is extracted when performing factor analysis, which explains most of the variation (>40%), it indicates that there is a significant common method bias. The results of the current showed that the first factor did not account for majority of the variance (only 23%), therefore, common method variance may not markedly affect the findings in this study. Second, the cross-sectional data in this study are limited in terms of causal inference. However, the mediation and moderation model used was based on theoretical guidance. Several important intrinsic and extrinsic factors that affect sleep quality in older adults were explored using the model. The cross-sectional study showed valuable information on variable interactions. Future studies should use longitudinal designs to evaluate the mediating and moderating model used in the current study and explore other factors that affect sleep quality in older adults, such as life satisfaction, self-efficacy, loneliness, ageism, chronic physical diseases and death anxiety. Third, this study was conducted with a sample of older men in Guangdong Province, China. Therefore, further studies should be conducted in other provinces in China, and female participants should be included as a control group. Further studies should also be conducted with older men from other cultures and other countries as participants.

Despite these limitations, the findings of the present study have several theoretical and practical implications. The findings indicate the relationship between sleep quality and perceived social support and rumination, and physical activity in older men. This information enriches the literature on the field of sleep quality and physical activity. In addition, the study findings provide a basis to further understand the relationship between perceived social support and sleep quality by exploring the relationship between perceived social support and sleep quality in older men. The results show the mediating role of rumination as well as the moderating role of physical activity on the relationship between perceived social support and sleep quality. These findings provide a basis for authorities to design effective prevention and intervention approaches to improve sleep quality in older men. For example, authorities can promote increased communication between older men and family members or friends and active participation in moderate to intense physical activity to improve sleep quality in this population. In addition, older care service practitioners should pay more attention to older men with less physical activity and more rumination, educate them on the negative effects of rumination, and guide them to ruminate less and be more active.

5. Conclusions

The mental health problems of older men are major public concern owing to the significant increase in the aging population in CHINA. Notably, sleep quality is an important indicator of the level of mental health. The purpose of the present study was to explore the relationships among perceived social support, rumination, physical activity, and sleep quality. Perceived social support and rumination are predictors of sleep quality. Sleep quality improves with increase in perceived social support, and rumination plays a partial mediating role in the relationship between perceived social support and sleep quality. This indicates that the negative impact of rumination can be alleviated by increasing the social support to older men, thus improving sleep quality. Physical activity significantly positive modulates the relationship between perceived social support and sleep quality, indicating the importance of physical activity on the mental health of older men. Notably, middle-high intensity physical activity significantly higher moderating effect compared with low intensity. Therefore, older men should carry out physical activities of a certain intensity, preferably middle and above level, to improve their sleep quality.

The exploration of this mediating role has practical implications: on the one hand, it further identifies the positive effect of perceived social support on improving sleep quality in older adults, and on the other hand, the discovery of this mediating mechanism will help inspire researchers to reduce sleep disturbances in older men by improving the ability to perceive social support and reduce ruminative thinking, and to discover more ways to benefit sleep in older adults.

This moderating effect of physical activity has practical significance. Physical functions significantly decline with increase in age. Decline in physical functions affects the well- being of older people, increasing occurrence of anxiety and depression and affecting the quality of sleep. Therefore, communities should actively advocate for regular and active participation in daily physical activities, such as housework, volunteering, and physical activities by the older to delay the decline in physical functions among older adults. Moreover, older men should minimize the time they sit and improve their movement to improve their mental health and sleep quality.

Author Contributions

HL—Study design, data acquisition, manuscript preparation, and the critical revision of the paper, important intellectual content. JH—Data management and data analysis, data interpretation, writing. BH—Manuscript review, writing. LX—Manuscript preparation, and editing. HH—Manuscript preparation, and editing. WL—Manuscript preparation, data acquisition, writing. All authors read and approved the final manuscript.

Ethics Approval and Consent to Participate

Investigation has been conducted in accordance with the ethical standards and according to the Declaration of Helsinki and national and international guidelines. This study was approved by the Ethics Committee of the Guangdong University of Finance & Economics with the number: GUFE-ECI-202105. All participants gave their informed consent for inclusion before they participated in the study.

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Conflict of Interest

The authors declare no conflict of interest.

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