sustainability

Communication

Subjective Happiness Is Associated with Objectively Evaluated Sleep Efficiency and Heart Rate during Sleep: An Exploratory Study Using Non-Contact Sheet Sensors

Hisayoshi Okamura [1,*], Kengo Mihara [1], Akira Tsuda [2], Toshihiro Morisaki [3], Yoshiyuki Tanaka [4] and Yoshihisa Shoji [1,5]

1 Cognitive and Molecular Research Institute of Brain Diseases, Kurume University, 67 Asahi-machi, Kurume, Fukuoka 830-0011, Japan; mihara_kengo@kurume-u.ac.jp (K.M.); yshoji@med.kurume-u.ac.jp (Y.S.)
2 Department of Psychology, Kurume University, 67 Asahi-machi, Kurume, Fukuoka 830-0011, Japan; tsuda_akira@kurume-u.ac.jp
3 Department of environmental medicine, Kurume University School of Medicine, 67 Asahi-machi, Kurume, Fukuoka 830-0011, Japan; bun.ching@gmail.com
4 Faculty of Health Science, Kyoto Tachibana University, 34 Yamada-cho Oyake, Yamashina-ku, Kyoto 607-8175, Japan; tanaka-yoshi@tachibana-u.ac.jp
5 Department of Psychiatry, Kurume University School of Medicine, 67 Asahi-machi, Kurume, Fukuoka 830-0011, Japan
* Correspondence: okamura_hisayoshi@med.kurume-u.ac.jp; Tel.: +81-942-31-7581

Received: 23 March 2020; Accepted: 3 June 2020; Published: 5 June 2020

Abstract: The objective of this study was to explore the relationship between subjective happiness and subjective and objective sleep. The participants were 24 healthy university students (11 males, 13 females; mean age 22.4 ± 2.1). Their subjective happiness was measured by the Japanese Subjective Happiness Scale (JSHS). Furthermore, their subjective and objective sleep evaluation was measured by Ogri-Shirakawa-Azumi sleep inventory MA version (OSA-MA) and a non-contact sheet sensor (SS). The results indicated that participants with higher subjective happiness had objectively shorter sleep onset latency, higher sleep efficiency, and lower heart rate during sleep. On the other hand, no such correlations were found between subjective sleep evaluation with OSA and subjective happiness. These results suggest that subjective happiness is related with the ability to more easily fall asleep and better sleep efficiency.

Keywords: subjective happiness; subjective sleep; objective sleep; non-contact sheet sensor

1. Introduction

In recent years, human subjective happiness (or, in a broader sense, subjective well-being) has garnered attention in developed countries as a topic in various fields, including psychology, medicine, philosophy, economics, and sociology. Subjective happiness is an intrinsic human function representing an individual's evaluation of their daily life. The concept comprises affective aspects, such as the extent of positive and negative emotions, and cognitive aspects assessing the degree to which one is satisfied with their day-to-day experiences and their lives as a whole [1]. Subjective happiness has previously been found to be beneficial to health and longevity, to have favorable effects on the function of neurological systems, metabolic systems, and immunological systems involved in promoting continued good health, and to be associated with cardiovascular function [2]. For example, subjective well-being has been reported to suppress the activation of noradrenergic neurons and excessive secretion of cortisol—a stress hormone—because of acute stress, and to be correlated with low levels of the typical inflammatory markers C-reactive protein (CRP) [3] and interleukin-6 (IL-6) [4]. Furthermore, increasing subjective happiness has been shown to enhance sleep quality and reduce blood pressure [5]. Thus, while verification of the role of subjective happiness in mental and physical health is underway, it has been suggested that increasing subjective happiness may contribute to the maintenance and enhancement of health. Yet, the types of factors that might elevate subjective happiness remain unclear.

Correlations between various health-related behaviors and subjective happiness have recently emerged [6]. Among health-related behaviors, sleep has been strongly correlated with happiness. Particularly, subjective happiness and positive affect have been associated with high-quality sleep and minimal sleep problems [7]. However, while the results of a systematic review on the relationship between positive affect and sleep concluded that subjective happiness and positive affect are correlated with sleep (length and quality), most of the data were from questionnaire surveys, and only 6 of 44 studies used objective sleep evaluations. The authors of the review thus indicated that, though conclusions must be made carefully due to so few studies having used objective sleep, use of objectively evaluated sleep would reduce measurement error and likely lead to less bias in effect estimation. The authors also indicated that more detailed examinations using both subjective and objective evaluations of sleep are necessary to clarify the correlations between sleep, health, and subjective happiness [8].

Shimai, Otake, Utsuki, Ikemi, and Lyubomirsky [9] created the Japanese Subjective Happiness Scale (JSHS) to clarify the characteristics of individuals who report feeling happy in various circumstances, and found that individuals with high JSHS scores had high life satisfaction, high self-esteem, and were physically healthy. Furthermore, JSHS scores have been found to negatively correlate with the cortisol awakening response and peripheral proinflammatory cytokine concentration [10,11]. The JSHS is useful as a standardized measure of subjective happiness.

Although polysomnography (PSG) is the gold standard for objective sleep evaluation, the method involves attaching electrodes to the head, which can inhibit natural sleep and can be difficult to conduct at home. Non-contact sheet sensors (SSs) are a recently-developed type of sensor confirmed to have the reliability and validity of PSG and actigraphy [12]. Thus, SSs constitute a convenient method for collecting sleep data, and can facilitate diagnoses, evaluations of treatment, and clinical research on sleep disorders. SSs can be used to objectively and conveniently evaluate sleep without requiring the subject to sleep with restraints. However, to our knowledge, no studies have examined the association between subjective happiness, which is recognized as being closely related to sleep quality, and objective sleep evaluations conducted using SSs. If data collected using SSs are found to accurately reflect subjective happiness, this will indicate that noninvasive at-home sleep measurements are possible, thereby significantly contributing to clarify the relationship between daily sleep habits and subjective happiness.

In this study, we conducted an exploratory investigation of the relationship between subjective happiness as measured by the JSHS, subjective sleep evaluated according to the Ogri-Shirakawa-Azumi sleep inventory MA version (OSA-MA), and objective sleep evaluated using SS.

2. Materials and Methods

2.1. Participants

Participants were recruited by phone and email. Participants were 24 healthy university students (11 males, 13 females; age range 19–26 years, mean age 22.4 ± 2.1 years) from whom consent to participate was obtained. It was confirmed in advance that experiment participants were free from any endocrine, eating, or psychiatric disorders and were not taking steroids or oral contraceptive medications.

2.2. Procedure

Participants were asked to come to the laboratory and were administered a questionnaire on their year in school, sex, age, and JSHS after an explanation of a simple study protocol and how to use the SS. They were asked to place the SS beneath their usual bedding at home and to perform the actual measurement (one night) after a one-night trial to confirm the monitor was operating properly. Participants were asked to complete the OSA-MA upon waking. They were not specifically instructed to perform on either weekdays or weekends but were asked to measure their sleep on days when they could maintain their regular life, including sleep patterns.

2.3. Questionnaire

SHS [9]: The SHS is a questionnaire measuring subjective happiness comprising 4 items, self-evaluated on a 7-point scale. For example, the first item asks participants to characterize themselves using absolute ratings from "not a very happy person" (1) to "a very happy person" (7). The scores from each item were averaged into a single JSHS composite score, with higher scores demonstrating a higher level of subjective happiness. The test-retest reliability, convergent validity, and discriminant validity of the SHS were confirmed through a series of studies to determine the characteristics of people who continue to be happy regardless of their circumstances.

OSA-MA [13]: The OSA-MA is a scale measuring subjective sleep quality upon waking, comprising 5 subscales and 16 items self-evaluated on a 4-point scale: Sleepiness on rising (e.g., "I have the ability to concentrate"), initiation and maintenance of sleep (e.g., "I slept very well"), frequent dreaming (e.g., "I frequently had a dream"), refreshing (e.g., "Fatigue still remains"), and sleep length (e.g., "I had a long sleep time"). The Z scores were calculated in order to adopt recommended statistical weighting score [14] for the following analysis, where a higher score demonstrates a worse subjective sleep quality.

2.4. Non-Contact Sheet Sensor

Objective sleep evaluation used the Sleep Monitor (Aisin Seiki Co., Ltd., Aichi, Japan). This device consists of a sleep monitor terminal and movement sensor sheet (The sheet size was 60 × 19 cm, with a thickness of 10 mm). The seat is equipped with six piezoelectric sensors, which detect vibrations. The vibration is sent to the analysis circuit and extracts the signal elements of body movement, heart rate, and respiration after filtering the signal. Sleep indicators are extracted and recorded based on this information. Therefore, simply spreading the sensor sheet beneath one's bedsheets allows simple measurement of total sleep time (TST), sleep onset latency (SOL), wake time after sleep onset (WASO), heart rate (HR), and respiration rate (RR) during sleep. It is also possible to evaluate sleep efficiency (SE) from these values.

2.5. Data Analysis

Data were analyzed using SPSS (Statistical Package for the Social Sciences) 20.0J for Windows. Correlations between JSHS score, sleep indicators measured by SS (TST, SOL, SE, WASO, HR, RR, and BM), and subscale scores of the OSA-MA (sleepiness on rising, initiation and maintenance of sleep, dreaming, refreshing, sleep length) were calculated using partial correlation coefficient controlling for the influence of sex. We also performed backward stepwise multiple regression analysis to examine the predictability of subjective happiness (single JSHS composite score) by subjective and objective sleep indicators; Subjective and objective sleep indicators as the object variable; JSHS composite score as the dependent variable; and sex, age, BMI and smoking habits as covariates. All statistical analyses were carried out with values below 5% treated as a significant difference and values below 10% treated as a significant trend.

2.6. Ethical Considerations

This study was carried out with the approval of the Ethics Committee of Kurume University. Participants provided consent after both an oral and written explanation that participant safety would be prioritized, research results data anonymized and used only for research purposes, privacy would be strictly observed, there would be no disadvantages to declining to participate, and that subjects could revoke their participation freely at any time even after participating.

3. Results

3.1. Participants Characteristics

The participants' characteristics are shown in Table 1. Approximately half (54%) of the subjects were women, and the mean JSHS score was 4.8. The mean BMI was 21.12, and most of the participants did not habitually smoke (91.7%) or drink alcohol (95.8%). The mean TST was 345.6 min, SOL was 7.8 min, and the SE was 97.8% as measured by the SS.

Table 1. Characteristics of the participants.

Variable	
Age (years)	22.42 (2.1)
Gender (% female)	54.2%
BMI	21.12 (3.15)
JSHS	4.75 (1.03)
OSA-MA	
Sleepiness on rising	13.88 (5.21)
Initiation and maintenance of sleep	17.13 (6.49)
Frequent dreaming	24.25 (7.93)
Refreshing	14.62 (5.68)
Sleep length	14.73 (7.47)
Non-contact sheet sensor	
TST (min)	345.58 (61.48)
SOL (min)	7.83 (4.41)
SE (%)	97.80 (1.36)
WASO (min)	13.29 (8.09)
HR (bpm)	60.08 (6.73)
RR (bpm)	15.16 (1.53)
Presently smoking (% No)	91.67%
Presently drinking (% No)	95.83%

3.2. The Relationship between Subjective and Objective Sleep Indicators

The correlation analysis of the sleep indicators measured by the SS and OSA-MA indicated that the TST, as measured by the SSs, was positively correlated with the "initiation and maintenance of sleep", "refreshing", and "sleep length" factor scores of the OSA-MA ($r = 0.53$, $p = 0.009$; $r = 0.64$, $p = 0.001$; $r = 0.48$, $p = 0.020$, respectively). Similarly, a positive correlation was observed for SE, as measured by the SS, and the "initiation and maintenance of sleep" factor score of the OSA-MA ($r = 0.46$, $p = 0.029$). Significant correlations were not found for any other sleep indicators.

3.3. The Relationship between Subjective Happiness and Sleep Indicators

We used partial correlation coefficient to examine the associations between JSHS scores and SS/OSA-MA sleep indicators (Table 2). As a result, significant correlations were confirmed between JSHS score and SOL ($r = -0.50$, $p = 0.014$), SE ($r = 0.52$, $p = 0.011$), and HR ($r = -0.44$, $p = 0.035$), as measured by the SS (Figure 1). Significant correlations were not observed between JSHS scores and any OSA-MA factor scores.

Table 2. Correlations between the JSHS score and sleep indicators after controlling for the influence of sex.

	Non-Contact Sheet Sensor						OSA-MA				
	TST	SOL	SE	WASO	HR	RR	Sleepiness on rising	Initiation and maintenance of sleep	Frequent dreaming	Refreshing	Sleep length
JSHS	−0.01	−0.50 *	0.52 *	0.03	−0.44 *	0.20	−0.20	0.08	−0.09	−0.07	−0.02

JSHS: Japanese Subjective Happiness Scale; OSA-MA: OSA sleep inventory MA version; TST: total sleep time; SOL: sleep onset latency; SE: sleep efficiency; WASO: wake time after sleep onset; HR: heart rate; RR: respiration rate. * $p < 0.05$.

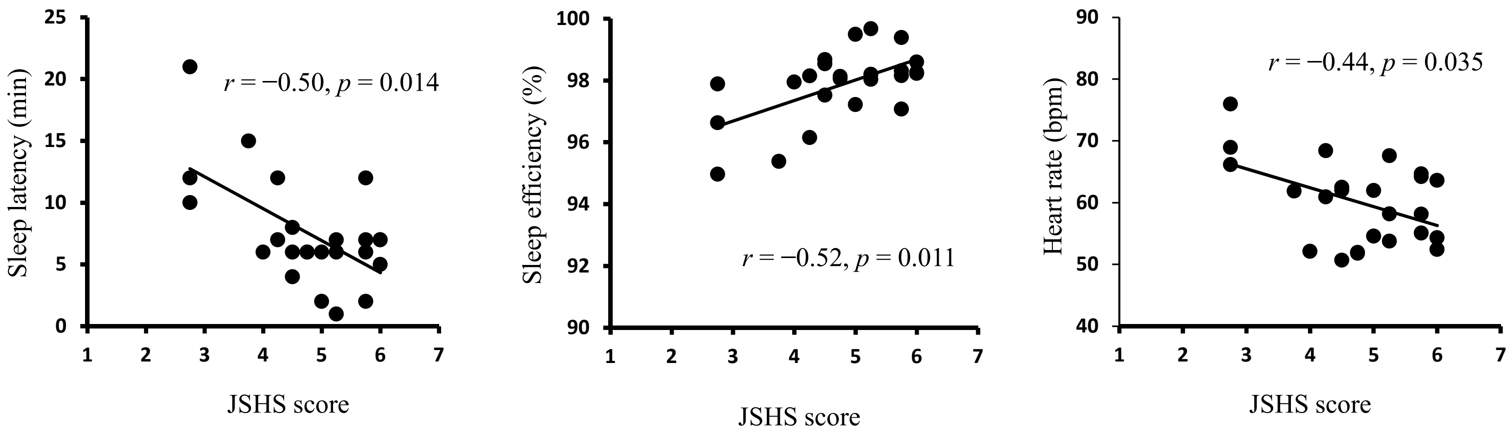

Figure 1. Scatter diagrams of correlations among JSHS score and objectively evaluated sleep onset latency, sleep efficiency and heart rate.

Backward stepwise multiple regression analysis was carried out to clarify the effects of sleep indicators on JSHS scores with each sleep indicator as an explanatory variable, JSHS score as the target variable, and sex, age, BMI, alcohol consumption, and smoking habits as covariates (Table 3). Consequently, SE ($\beta = 0.45$, R^2 change = 0.195, $p = 0.018$) and HR ($\beta = -0.33$, R^2 change = 0.104, $p = 0.076$), as measured by SS, had significant coefficients of determination ($R^2 = 0.38$, Adjusted $R^2 = 0.32$, $p = 0.007$). The correlation coefficients between explanatory variables were all $\leq r = 0.70$ and the variance inflation factors (VIF) were all ≤ 5, ruling out the possibility of multicollinearity.

Table 3. Backward stepwise multiple regression of JSHS score by sleep indicators.

	β	ΔR^2	t	*p* Value	VIF
OSA-MA					
Sleepiness on rising	-	-	-	-	-
Initiation and maintenance of sleep	-	-	-	-	-
Frequent dreaming	-	-	-	-	-
Refreshing	-	-	-	-	-
Sleep length	-	-	-	-	-
Non-contact sheet sensor					
TST	-	-	-	-	-
SOL	-	-	-	-	-
SE	0.45	0.20	2.56	0.018	1.05
WASO	-	-	-	-	-
HR	−0.33	0.10	−1.87	0.076	1.05
RR	-	-	-	-	-

JSHS: Japanese Subjective Happiness Scale; OSA-MA: OSA sleep inventory MA version; TST: total sleep time; SOL: sleep onset latency; SE: sleep efficiency; WASO: wake time after sleep onset; HR: heart rate; RR: respiration rate Adjusted for sex, age, BMI and smoking habits.

4. Discussion

In this exploratory study, we examined the relationship between subjective happiness and objective sleep, as measured by SS, and that with subjective sleep, as measured by the OSA-MA during one night in university students. The results revealed that participants with higher levels of subjective happiness, as measured by the JSHS, had higher objective sleep quality. Furthermore, although only a significant trend, lower heart rate during sleep was correlated with higher subjective happiness. Conversely, no such correlations were found between subjective sleep, as evaluated using the OSA-MA, and subjective happiness. This suggests that subjective happiness is closely related to objective sleep quality, and furthermore, that subjective happiness might be related to subjective and objective sleep evaluations in different ways.

The correlation analysis between sleep variables measured via SS and subjective sleep quality revealed that objective sleep time and sleep efficiency were correlated with subjective sleep quality ("initiation and maintenance of sleep", "refreshing," and "sleep length") upon waking. The reliability and validity of SSs have already been confirmed through simultaneous measurement with PSG and actigraphy [12]. Our data also supported the efficacy of SSs as an accurate method of measuring subjective sleep quality upon waking.

The results of our correlation analysis and multiple regression analysis for subjective happiness and sleep variables confirmed moderate positive correlations between JSHS scores and objective sleep latency, sleep efficiency, heartrate during sleep, and identified sleep efficiency as a factor influencing subjective happiness. Higher subjective happiness has been correlated with lower levels of rumination on negative thoughts before falling asleep, higher quality sleep, fewer sleep problems, a shorter period between falling asleep and reaching deep sleep, and fewer bodily movements during sleep [15–17]. Furthermore, high-quality sleep and ease of falling asleep have been found to correlate with recovery from fatigue and good physical health, which are known to improve quality of life (QOL) [18]. These findings suggest that university students with higher levels of subjective happiness might fall asleep more easily and have higher sleep efficiency, which could lead to better subjective ratings of health.

Although marginally significant, heart rate during sleep was found to be a factor relating to subjective happiness. Positive affect—particularly a calm mood and feelings of satisfaction—has been shown to correlate with low heart rate during sleep [19]. Additionally, activity in the parasympathetic nervous system has been found to be predominant during non-REM sleep, reducing physiological functions such as heart rate variability, respiration rate, blood pressure, and body temperature [20,21]. Moreover, Okano, Tochikubo, and Uemura [22] indicated that individuals with better cardiovascular function during sleep have higher health-related QOL. These previous data and our current findings suggest that subjective happiness may be correlated with cardiovascular function during sleep, and consequently, that cardiovascular function during sleep may have important effects on physical and mental health, as well as daily social activity. Further detailed investigations regarding the relationship between subjective happiness and physiological function during sleep are necessary to clarify these relationships.

We found no significant correlations between subjective happiness and subjective sleep quality, as measured by the OSA-MA. This may reflect the utility of the OSA-MA in analyzing the psychological aspects of sleep on the awake, rather than to obtain subjective evaluations of sleep latency, sleep time, and sleep quality. These results also may reflect that both subjective and objective sleep evaluations were carried out for only one night. Further examinations of the relationship between subjective happiness and subjective sleep quality by long-term nighttime measurements may benefit from the use of subjective sleep evaluation methods that measure sleep problems (insomnia, inadequate sleep time, and poor sleep quality), as well as other sleep questionnaires such as the Pittsburgh Sleep Quality Index (PSQI) [23] or the 3 Dimensional Sleep Scale (3DSS) [24].

This study has several limitations. First, this study lacked statistical power due to the small sample size taken from a limited population of university students. Additionally, consideration of confounding factors, such as health behaviors and BMI, was limited. For these reasons, future studies that consider additional confounding factors, such as psychosocial factors, diet, and physical activity, with larger samples with different ages and occupations, including workers, are required to clarify the generalizability of our results. Next, both subjective and objective sleep evaluations were carried out for only one night. Sleep is thought to be strongly affected by psychological stress or the events of the day. Therefore, longer-term sleep evaluations that include both weekdays and weekends are necessary. Furthermore, the average SE of all participants was 97.8%, which was a remarkably high value. Further studies regarding the relationship between subjective happiness and subjective and objective sleep for populations with lower SE are necessary. Finally, because this was a cross-sectional study, the causal relationship between subjective happiness and sleep remains unclear. Subjective happiness and sleep have been observed to exert a bidirectional influence on one another in which both are causes and effects [8,15]. Longitudinal or interventional research will enable exploration of the causal relationship between the two variables.

5. Conclusions

This study was an exploratory investigation of the relationship between subjective happiness and subjective and objective sleep evaluations in university students. Our results indicated that higher levels of subjective happiness are associated with objectively shorter sleep onset latency, higher sleep efficiency, and lower heartrate during sleep. Further research is needed to measure long-term nighttime sleep in a large sample and clarify the function and role of subjective happiness in sleep, physical health, and mental health, including relationships with psychosocial factors.

Author Contributions: Conceptualization, H.O., K.M., A.T. and Y.S.; methodology, H.O. and K.M.; formal analysis, H.O., K.M., T.M. and Y.T.; data curation, H.O. and K.M.; writing—original draft preparation, H.O. and K.M.; writing—review and editing, H.O., A.T., Y.T. and Y.S.; supervision, H.O. and A.T.; project administration,

H.O. and K.M.; funding acquisition, H.O. and A.T. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the Japan Society for the Promotion of Science, and The Ministry of Education, Culture, Sports, Science, and Technology (Grant-in-Aid for Scientific Research B15H03459 and Grant-in-Aid for Young Scientists B16K17351)

Acknowledgments: We are grateful to the students who participated in this study. We thank Sydney Koke, MFA, for editing a draft of this manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Diener, E.; Suh, E.M.; Lucas, R.E.; Smith, H.L. Subjective well-being: Three decades of progress. *Psychol. Bull.* **1999**, *125*, 276–302. [CrossRef]
2. Steptoe, A. Happiness and health. *Ann. Rev. Public Health* **2019**, *4*, 339–359. [CrossRef]
3. Steptoe, A.; O'Donnell, K.; Badrick, E.; Kumari, M.; Marmot, M.G. Neuroendocrine and inflammatory factors associated with positive affect in healthy men and women: Whitehall II study. *Am. J. Epidemiol.* **2008**, *167*, 96–102. [CrossRef]
4. Prather, A.A.; Marsland, A.L.; Muldoon, M.F.; Manuck, S.B. Positive Affective Style Covaries with Stimulated IL-6 and IL-10 Production in a Middle-Aged Community Sample. *Brain Behav. Immun.* **2007**, *21*, 1033–1037. [CrossRef] [PubMed]
5. Jackowska, M.; Brown, J.; Ronaldson, A.; Steptoe, A. The impact of a brief gratitude intervention on subjective well-being, biology and sleep. *J. Health Psychol.* **2015**, *21*, 2207–2217. [CrossRef] [PubMed]
6. Boehm, J.K.; Kubzansky, L.D. The Heart's Content: The Association between Positive Psychological Well-Being and Cardiovascular Health. *Psychol. Bull.* **2012**, *138*, 655–691. [CrossRef] [PubMed]
7. Otsuka, Y.; Kaneita, Y.; Itani, O.; Jike, M.; Osaki, Y.; Higuchi, S.; Kanda, H.; Kinjo, A.; Kuwabara, Y.; Yoshimoto, H. The relationship between subjective happiness and sleep problems in Japanese adolescents. *Seep Med.* **2020**, *69*, 120–126. [CrossRef]
8. Ong, A.D.; Kim, S.; Young, S.; Steptoe, A. Positive affect and sleep: A systematic review. *Sleep Med. Rev.* **2017**, *35*, 21–32. [CrossRef]
9. Shimai, T.; Otake, K.; Utsuki, N.; Ikemi, A.; Lyubomirsky, S. Development of a Japanese version of the subjective happiness scale (SHS), and examination of its validity and reliability. *Jpn. J. Public Health* **2004**, *51*, 845–853. (In Japanese) [CrossRef]
10. Okamura, H.; Tsuda, A.; Matsuishi, T. Perceived happiness and cortisol awakening response on workdays and weekends. *J. Health Psychol. Res.* **2010**, *23*, 11–21. (In Japanese) [CrossRef]
11. Matsunaga, M.; Hiroshi Kaneko, H.; Tsuboi, H.; Kawanisi, Y. Psychosomatic Approach to Health from the Perspective of Positive Psychology. *Jpn. Psychosom. Med.* **2011**, *51*, 135–140.
12. Uchida, S.; Endo, T.; Suenaga, K.; Iwami, H.; Inoue, S.; Fujioka, E.; Imamura, A.; Atsumi, T.; Inagaki, Y.; Kamei, A. Sleep evaluation by a newly developed PVDF sensor non-contact sheet: A comparison with standard polysomnography and wrist actigraphy. *Sleep Biol. Rhythm.* **2011**, *9*, 178–187. [CrossRef]
13. Yamamoto, Y.; Tanaka, H.; Takase, M.; Shirakawa, S. Standardization of revised version of OSA sleep inventory for middle age and aged. *Brain Sci. Ment. Disord.* **1999**, *10*, 401–409. (In Japanese)
14. Oguri, M.; Shirakawa, S.; Azumi, K. 1985 Construction of standard rating scale to estimate sleep profile. *Clin. Psychiatry* **1985**, *27*, 791–799. (In Japanese)
15. Ryff, C.D.; Singer, B.H.; Love, G.D. Positive health: Connecting well-being with biology. *Philos. Trans. R. Soc. Lond.* **2004**, *359*, 1383–1394. [CrossRef] [PubMed]
16. Steptoe, A.; O'Donnell, K.; Marmot, M.; Wardle, J. Positive affect, psychological well-being, and good sleep. *J. Psychosom. Res.* **2008**, *64*, 409–415. [CrossRef]
17. Stewart, J.C.; Rand, K.L.; Hawkins, M.A.W.; Stines, J.A. Associations of the shared and unique aspects of positive and negative emotional factors with sleep quality. *Personal. Individ. Differ.* **2011**, *50*, 609–614. [CrossRef]
18. Tanaka, H.; Shirakawa, S. Sleep health, lifestyle and mental health in the Japanese elderly: Ensuring sleep to promote a healthy brain and mind. *J. Psychosom. Res.* **2004**, *56*, 465–477. [CrossRef]

19. Schwerdtfeger, A.R.; Friedrich-Mai, P.; Gerteis, A.K. Daily Positive Affect and Nocturnal Cardiac Activation. *Int. J. Behav. Med.* **2015**, *22*, 132–138. [CrossRef]
20. Busek, P.; Vankova, J.; Opavsky, J.; Salinger, J.; Nevimlova, S. Spectral analysis of the heart rate variability in sleep. *Physiol. Res.* **2005**, *54*, 369–376.
21. Snyder, F.; Hobson, J.A.; Morrison, D.F.; Goldfrank, F. Changes in respiration, heart rate, and systolic blood pressure in human sleep. *J. Appl. Physiol.* **1964**, *19*, 417–422. [CrossRef] [PubMed]
22. Okano, Y.; Tochikubo, O.; Uemura, S. Relationship between base blood pressure during sleep and health-related quality of life in healthy adults. *J. Hum. Hypertens.* **2007**, *21*, 135–140. [CrossRef] [PubMed]
23. Buysse, D.J.; Reynolds, C.F., III; Monk, T.H.; Berman, S.R.; Kupfer, D.J. The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Psychiatry Res.* **1989**, *28*, 193–213. [CrossRef]
24. Matsumoto, Y.; Uchimura, N.; Ishida, T.; Morimatsu, Y.; Mori, M.; Inoue, M.; Kushino, N.; Hoshiko, M.; Ishitake, T. The relationship of sleep complaints risk factors with sleep phase, quality, and quantity in Japanese workers. *Sleep Biol. Rhythms.* **2017**, *15*, 291–297. [CrossRef]