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Sleep hygiene behaviours in Iranian adolescents: an application of the Theory of Planned Behavior

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SUMMARY

Poor sleep quality and inadequate sleep in adolescents are a rising trend globally. The Theory of Planned Behaviour (TPB)—which centres on an individual's attitude toward performing the behaviour, subjective norms and perceived behavioural control—has been applied to examine sleep hygiene behaviours in young adults. We expanded on prior works by using a longitudinal design to examine the effects of TPB factors, together with sleep hygiene knowledge and planning constructs, on sleep hygiene behaviours and on sleep quality and health in a group of Iranian adolescents. A total of 1822 healthy adolescents (mean age = 13.97) from 25 high schools in Qazvin, Iran, completed a self-reported survey at baseline and 6 months later. Structural equation modelling (SEM) was used to delineate the pathway from adolescents' sleep hygiene knowledge, TPB constructs of their behavioural intentions and sleep hygiene behaviours and their sleep quality and self-reported health. The SEM model demonstrated that although behavioural intention, coping planning and action planning predicted the sleep hygiene behaviours positively 6 months later with acceptable model fit [comparative fit index (CFI) = 0.936; Tucker–Lewis index (TLI) = 0.902; root mean square error of approximation (RMSEA) = 0.080; standardized root mean square residual (SRMR) = 0.044], sleep hygiene knowledge did not predict behavioural intentions significantly. Sleep hygiene behaviours were associated with sleep quality and psychiatric wellbeing. Thus, the TPB, combined with coping and action planning, is useful in understanding the sleep hygiene behaviours of adolescents. Health-care providers may want to emphasize TPB constructs and coping and action planning to improve adolescents' sleep hygiene behaviours, rather than rely solely upon increasing adolescents' sleep hygiene knowledge.

INTRODUCTION

Sleep plays an important role in several domains of brain function and behaviour in adolescents (Tarokh *et al.*, 2016). Poor sleep is associated with poor mental health, such as depression and anxiety, and affects learning, memory and attention in adolescents (Tarokh *et al.*, 2016). Good sleep helps to optimize daily performance, such as working memory and capacity for learning, and reduces excessive daytime sleepiness (Gradisar *et al.*, 2008). Although sufficient sleep in a regular sleep–wake pattern is strongly recommended for adolescents (Chaput *et al.*, 2016), the substantial attractions of technology nowadays may be one of the factors preventing adolescents from having good sleep hygiene behaviours (Hysing *et al.*, 2015). Therefore, improving sleep hygiene behaviours for adolescents is a critical issue.

Sleep hygiene refers to the steps that individuals undertake to optimize their sleep quality, such as maintaining regular

sleep schedules and reducing caffeine intake, especially at night (Brown *et al*., 2002). An Australian study showed that nearly 30% of 11- to 17-year-old adolescents delayed their sleep onset time and, on average, each adolescent woke up 1.2 times at night (Gamble *et al*., 2014). Considering the rising trend of sleep problems and inadequate sleep in adolescents (Kronholm *et al*., 2015) and the negative impact of inadequate sleep on health and functioning in adolescents (Shochat *et al*., 2014), studies that use behaviour-orientated theories to understand sleep problems and to plan interventions are needed.

The Theory of Planned Behaviour (TPB)—a widely used theory to explain how an individual's motivational factors determine the likelihood of performing health behaviours (Ajzen, 1985; Montano and Kasprzyk, 2015)—is a possible framework to understand sleep hygiene behaviours in adolescents. The TPB has been applied successfully to understanding a variety of health behaviours, including sleep hygiene behaviours (De Leeuw *et al*., 2015; Kor and Mullan, 2011; Lao *et al*., 2016; Mairs and Mullan, 2015; Pakpour *et al*., 2011, 2012). According to the TPB, the most salient predictor of behaviour is behavioural intention which is determined, in part, by an individual's attitude towards performing the behaviours, subjective norm and perceived behavioural control (Ajzen, 1985). In the TPB, favourable attitudes reflect a belief that a behaviour will produce a desired outcome. TPB also purports that a person can be motivated by subjective perceptions of what other people consider normal and acceptable behaviour (Ajzen, 1985); hence, an individual's subjective norms represents an individual's perception of how specific individuals or groups agree with the behaviour and how much an individual want to comply with these referents (Ajzen, 1985). An individual's perceived behavioural control represents one's perception of the extent to which they can control the behaviour (Ajzen, 1985; Montano and Kasprzyk, 2015).

Although TPB has been used widely to understand intentions and behaviour, Sniehotta *et al.* (2005) questioned whether behavioural intentions alone can account sufficiently for lifestyle or health behaviour changes. To explain the missing link between intentions and behaviours, they proposed that coping planning and action planning should predict behaviour above and beyond intention. Coping planning refers to a strategy of self-regulating to cope with anticipated obstacles by implementing preplanned detailed action (Sniehotta *et al*., 2005). Action planning refers to a strategy to initiate action that identifies clearly when, where and how to pursue an action that collaborates with implementation intentions (Sniehotta *et al*., 2005). Studies that assess action planning and coping planning, in addition to TPB constructs, have shown that these factors effectively predict adherence to healthy behaviours (Lin *et al*., 2016; Pakpour *et al*., 2011).

Theory of Planned Behaviour has been used as one possible theory to explain sleep hygiene behaviours in college student samples (Knowlden *et al*., 2012; Kor and Mullan, 2011; Lao *et al*., 2016). All found that perceived behavioural control and subjective norm predicted intention (Knowlden *et al*., 2012; Kor and Mullan, 2011; Lao *et al*., 2016). Subjective norm was the strongest predictor of intention, while attitudes were not associated significantly with intention in the study by Kor and Mullan (2011). Thus, the literature supports the use of TPB in understanding sleep hygiene behaviour, yet also points out that researchers may improve the prediction of sleep behaviour by including constructs from other theories. For example, Kor and Mullan (2011) used TPB constructs and perceived autonomy support to predict intention to perform sleep hygiene behaviours and behaviours themselves. They found that TPB constructs explained only 12.8% of variance in predicting intention, which was relatively low compared to the variance accounted for by TPB constructs in other studies.

Accordingly, knowledge of sleep hygiene is one additional construct that has been associated with better sleep quality (Brown *et al*., 2002; Chaiarj *et al*., 2002). Indeed, improving people's knowledge of sleep hygiene may serve as an important part of intervention and prompt behavioural changes that lead to improved health outcomes. However, the association between knowledge and TPB constructs, such as attitude and perceived behavioural control, has not been examined together in relation to sleep behaviour. The purpose of the study was to use a longitudinal design incorporating the TPB constructs, along with sleep hygiene knowledge and planning constructs, to predict sleep hygiene behaviour, sleep quality and health in a group of Iranian adolescents. We expected sleep hygiene knowledge and TPB constructs, including attitude, subjective norm and perceived behavioural control, to correlate positively with behavioural intention. Further, we expected behavioural intention, coping and action planning to predict sleep hygiene behaviour positively, which then correlate with better psychiatric wellbeing directly and indirectly via better sleep quality (Fig. 1).

METHODS

Participants and procedures

We recruited healthy adolescents from high schools in Qazvin, Iran. The study protocol was approved by the Research Ethics Committee of Qazvin University of Medical Sciences (protocol 369). Students had to be aged 12 years or older, had the ability to understand written and spoken Persian and have agreed to participate. Students were excluded from the study if they were undergoing treatment for a sleep disorder. Assent was obtained from adolescents, and informed consent was obtained from parents or guardians prior to participation in the study. From January to December 2015, we invited 1900 adolescents from 25 high schools in Qazvin City (a city near Tehran) to participate, and 1822 agreed. Surveys were administered at the schools in Persian.

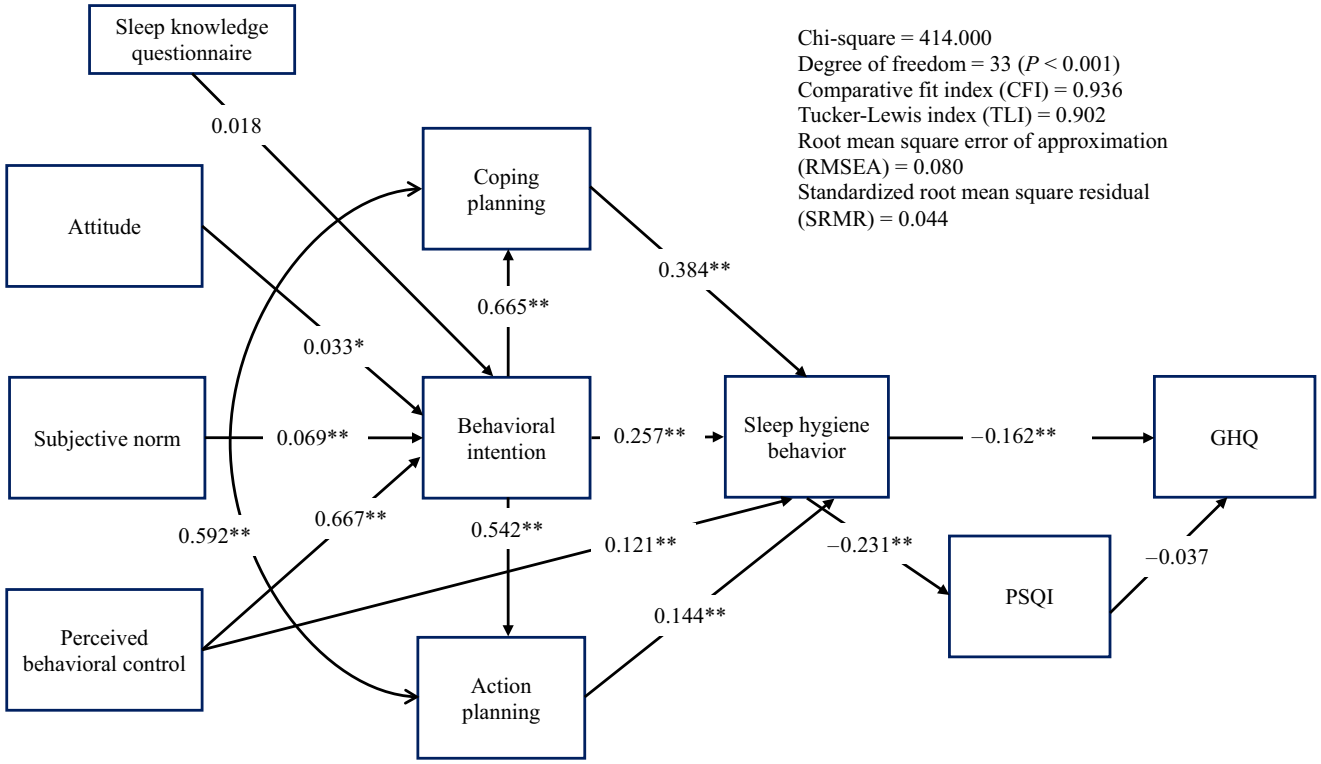

Figure 1. Age and sex were adjusted for scores of the Pittsburgh Sleep Quality Index (PSQI) and the General Health Questionnaire (GHQ); higher scores of PSQI and GHQ indicate worse sleep quality and health, respectively. *$P < 0.1$; **$P < 0.001$.

Measures

Pittsburgh Sleep Quality Index (PSQI)

PSQI is a self-rated questionnaire used commonly for measuring sleep quality and disturbances in clinical patients (Buysse *et al.*, 1989) and undergraduate students (Brown *et al.*, 2002; Pilcher *et al.*, 1997). A total of 19 items, each rated on a 0–3 scale, are distributed into seven components: duration of sleep, sleep disturbance, sleep latency, day dysfunction due to sleepiness, sleep efficiency, overall sleep quality and medications needed to sleep. A total score can be summed by the seven components; a higher score indicates worse sleep quality. A total score above or equal to 5 represents poor sleep quality (Grandner *et al.*, 2006). The PSQI has been translated into Persian for Iranians with satisfactory reliability ($\alpha = 0.77$) and validity (Moghaddam *et al.*, 2012).

General Health Questionnaire-12 (GHQ)

The GHQ is a self-reported questionnaire that measures the health, especially the psychiatric wellbeing, of an individual. The original GHQ contained 60 items, but shortened versions (i.e. 30-, 28-, 20-, and 12-item) have been validated (Sánchez-López and Dresch, 2008). We used the 12-item version in this study due to its effectiveness, validity and feasibility. The 12-item GHQ has also been validated linguistically into Persian with satisfactory internal consistency ($\alpha = 0.87$) and concurrent validity ($r = -0.56$ with a quality of life measure) (Montazeri *et al.*, 2003). All items were rated on a 0–3 scale; higher scores indicate worse health.

Sleep knowledge questionnaire

The sleep knowledge questionnaire was developed by Gallasch and Gradisar (2007) to assess knowledge about the impact of certain sleep hygiene behaviour on sleep. The sleep knowledge questionnaire consists of 15 items, with each item scored via true/false/don't know answers: a correct answer scores 2; a 'don't know' answer scores 0; an incorrect answer scores −2. All item scores were summated (range between −30 and 30), such that higher scores indicate better sleep hygiene knowledge. Sample items include: 'Drinking three standard glasses of alcohol has no effect on sleep' and 'If you cannot fall asleep within 20 min, you should get out of bed and try again later'. The internal consistency of the sleep knowledge questionnaire is somewhat acceptable ($\alpha = 0.65$) (Gallasch and Gradisar, 2007).

Theory of Planned Behaviour

Based on the TPB, we adopted items developed by Kor and Mullan (2011) to assess four constructs (attitude, subjective norm, perceived behavioural control and behavioural intention). All items were measured using a five-point Likert scale.

Sleep hygiene behaviour measurement was based on items developed by Todd and Mullan (2014).

- *Attitude* was assessed by 12 items that measured belief-based attitudes towards sleep hygiene behaviours with high internal consistency ($\alpha = 0.96$). A sample item was: 'To make my bedroom/sleep environment restful would make me feel rested in the morning'.
- *Subjective norm* used three items, each measuring a behavioural component. The internal consistency was satisfactory ($\alpha = 0.91$). A sample item was: 'People who are important to me think I should not have anxiety-provoking activity before bedtime'.
- *Perceived behavioural control* consisted of three items, each assessing self-efficacy, controllability or confidence. The internal consistency was adequate ($\alpha = 0.88$). A sample item was: 'I am confident that every day I can prevent anxiety-provoking activity before bedtime'.
- *Sleep hygiene behaviour* used three items to measure how many days the participants had good sleep hygiene behaviour. The internal consistency was acceptable ($\alpha = 0.78$). A sample item was: 'How many days did you make your bedroom restful over the past week?'. The other questions asked whether adolescents avoided going to bed feeling hungry or thirsty, and avoided anxiety and stress-provoking activity before bed. All three items have eight possible responses, ranging from 0 to 7 days.
- *Behavioural intention* was assessed by six items covering three aspects of intention tied to the three aspects of behaviour. Each aspect was assessed by two items. The internal consistency was satisfactory ($\alpha = 0.86$). A sample item was: 'Over the next week, I intend to make my bedroom restful'.

Action planning and coping planning

Action planning and coping planning measures were based on studies by Pakpour and colleagues (Pakpour *et al.*, 2011, 2012).

Action planning was measured with a four-item scale, i.e.: 'I have made a detailed plan regarding (a) when, (b) where, (c) how and (d) how often to perform sleep hygiene behaviours over the next 6 months'. Each item was scored on a five-point Likert-type response option scale ranging from 'totally disagree' = 1 to 'totally agree' = 5. The internal reliability of these four items was 0.92.

Coping planning was assessed by five items, i.e.: 'I have made a detailed plan regarding what to do if something interferes with my plans'. The internal consistency reliability of the coping planning was 0.88. Both planning scores were calculated using the average score.

The sleep knowledge questionnaire and variables in TPB, except for the sleep hygiene behaviour, were assessed at baseline; sleep hygiene behaviour, PSQI and GHQ were assessed 6 months later.

Data analysis

Data were analysed using R software with different packages. The Hmisc package was used for descriptive statistics and the Lavaan package for structural equation modelling (SEM).

Descriptive statistics were used to demonstrate the mean [standard deviation (SD)] or *n* (%) for demographics and questionnaire scores. Pearson's correlations were used to calculate associations between variables in our proposed model. An SEM model (Fig. 1) was performed that examined how the TPB variables predicted consequent health outcomes (i.e. sleep quality measured by PSQI and psychiatric wellbeing measured by GHQ). After testing the model using all participants, we additionally tested the model using participants who had good sleep hygiene knowledge [i.e. sleep knowledge questionnaire (SKQ) scores above the medium] and those who had poor sleep hygiene knowledge (i.e. SKQ scores below the medium) to understand whether sleep quality moderated relationships in the model. Moreover, we adopted the Wald test to examine whether any coefficients were significantly different between the two groups (good versus poor sleep hygiene knowledge) to understand in depth the moderated role of sleep hygiene knowledge. Several indices were used to determine whether our data fitted well with the proposed model: comparative fit index (CFI) and Tucker–Lewis index (TLI) above 0.9 indicate adequate fit; root mean square of error of approximation (RMSEA) and standardized root mean square residual (SRMR) below 0.08 indicated adequate fit (Hoyle and Panter, 1995).

RESULTS

Table 1 presents demographics and questionnaire scores of the participants. Of the 1822 adolescents who participated, 72.8% were female and the average age was 13.97 (SD: 1.34). Most parents of the adolescents had a secondary school degree: 87.1% of fathers and 88.7% of mothers. A total of 773 adolescents showed good sleep hygiene knowledge (i.e. SKQ score >6); 835 showed poor sleep hygiene knowledge (i.e. SKQ score ≤6). Regarding PSQI domain score, the mean (SD) scores, skewness and kurtosis were 0.42 (0.81), 1.97 and 2.97 for duration of sleep; 1.23 (0.63), 0.55 and 0.71 for sleep disturbance; 1.04 (0.91), 0.51 and −0.57 for sleep latency; 0.99 (0.79), 0.61 and 0.92 for daytime dysfunction due to sleepiness; 0.26 (0.73), 2.86 and 7.13 for overall sleep quality; 0.63 (0.90), 1.39 and 0.97 for needing medications to sleep; and 0.25 (0.67), 2.84 and 7.39 for sleep efficiency. The skewness of the total score of PSQI was 1.19 and the kurtosis was 2.06. A total score above or equal to 5 represents poor sleep quality, and 44.2% of our sample was in this category.

Table 2 presents the correlations among the variables used in our SEM model. Sleep hygiene knowledge had low correlations with all other variables ($r = -0.08$ to 0.08); half the correlations were non-significant. GHQ and PSQI scores

Table 1 Participant demographics and questionnaire scores ($n = 1822$)

	n *(%) or mean ± SD*	*Range*
Age	13.97 ± 1.34	11.00–19.00
Sex (female)	1318 (72.8)	–
Educational level for father		
Illiterate	31 (1.8)	–
Primary school	194 (11.1)	–
Secondary school	284 (16.2)	–
Diploma	676 (38.6)	–
University	566 (32.3)	–
Educational level for mother		
Illiterate	39 (2.2)	–
Primary school	163 (9.1)	–
Secondary school	271 (15.2)	–
Diploma	739 (41.4)	–
University	572 (32.1)	–
Sleep hygiene knowledge	6.97 ± 8.12	–30 to 30
Attitude	4.15 ± 0.51	1–5
Subjective norm	3.37 ± 0.64	1–5
Perceived behavioural control	3.73 ± 0.90	1–5
Behavioural intention	3.83 ± 0.96	1–5
Coping planning	2.81 ± 0.89	1–5
Action planning	2.80 ± 0.86	1–5
Sleep hygiene behaviour	14.88 ± 8.83	0–28
General Health Questionnaire	18.30 ± 3.62	2–35
Pittsburgh Sleep Quality Index	4.64 ± 2.92	0–21

SD: standard deviation.

were correlated negatively with all the TPB variables ($r = -0.15$ to -0.07 for GHQ; $r = -0.23$ to -0.11 for PSQI); only one correlation was non-significant ($r = -0.04$ for GHQ score and subjective norm). All TPB variables were correlated significantly with each other ($r = 0.20$–0.73).

Our proposed model (Fig. 1) had acceptable model fit (CFI = 0.936; TLI = 0.902; RMSEA = 0.080; SRMR = 0.044), except for the significant chi-square ($\chi^2 = 414.00$, df = 33, $P < 0.001$). Based on the acceptable model fit, we additionally examined whether each of our proposed paths was significant. Only three paths were non-significant: sleep hygiene knowledge did not predict behavioural intention significantly (standardized coefficient = 0.018, $P = 0.301$); attitude predicted behavioural intention marginally significantly (standardized coefficient = 0.033, $P = 0.097$); PSQI score did not predict GHQ score significantly (standardized coefficient = −0.037, $P = 0.189$). Furthermore, coping planning predicted sleep hygiene behaviour more strongly (standardized coefficient = 0.384, $P < 0.001$) than did action planning (standardized coefficient = 0.144, $P < 0.001$).

Attitude, subjective norms and perceived behavioural control together explained 49.9% of the variance in behavioural intention. Behavioural intention, coping and action planning together explained 60.2% of the variance in sleep hygiene behaviour. Sleep hygiene explained 7.9% of the variance in PSQI and 3.2% of the variance in GHQ.

Our additional SEM models comparing those with poor sleep to those with good sleep demonstrated that sleep quality moderated the associations between sleep hygiene knowledge and behavioural intention and between sleep quality and psychiatric wellbeing. Specifically, behavioural intention had no significant correlation with sleep hygiene knowledge (standardized coefficient = 0.001, $P = 0.954$) and significant correlation with attitude (standardized coefficient = 0.069, $P = 0.022$); sleep quality had no significant correlation with psychiatric wellbeing (standardized coefficient = 0.008, $P = 0.836$) in the participants who had good sleep hygiene knowledge (Fig. 2). While behavioural intention was correlated marginally with sleep hygiene knowledge (standardized coefficient = 0.043, $P = 0.074$) but not correlated with attitude (standardized coefficient = −0.0018, $P = 0.521$), sleep quality was correlated marginally with psychiatric wellbeing (standardized coefficient = −0.079, $P = 0.061$) in those who had poor sleep hygiene knowledge

Table 2 Pearson's product correlation matrix among variables ($n = 1822$)

	1. SK	*2. Att*	*3. SN*	*4. PBC*	*5. Int*	*6. Coping*	*7. Action*	*8. Behav*	*9. GHQ*	*10. PSQI*
1. SK	1.00									
2. Att	0.03	1.00								
3. SN	0.03	0.30**	1.00							
4. PBC	0.08*	0.50**	0.24**	1.00						
5. Int	0.08*	0.39**	0.24**	0.70**	1.00					
6. Coping	0.08*	0.38**	0.26**	0.67**	0.66**	1.00				
7. Action	0.04	0.29**	0.26**	0.50**	0.54**	0.73**	1.00			
8. Behav	0.08*	0.38**	0.20**	0.63**	0.67**	0.73**	0.62**	1.00		
9. GHQ	−0.04	−0.07*	−0.04	−0.11**	−0.11**	−0.11**	−0.13**	−0.15**	1.00	
10. PSQI	−0.08*	−0.20**	−0.11**	−0.23**	−0.19**	−0.21**	−0.15**	−0.23**	0.01	1.00

SK: sleep hygiene knowledge; Att: attitude; SN: subjective norm; PBC: perceived behavioural control; Int: behavioural intention; Coping: coping planning; Action: action planning; Behav: sleep hygiene behaviour; GHQ: General Health Questionnaire; PSQI: Pittsburgh Sleep Quality Index.
*$P < 0.01$; **$P < 0.001$.

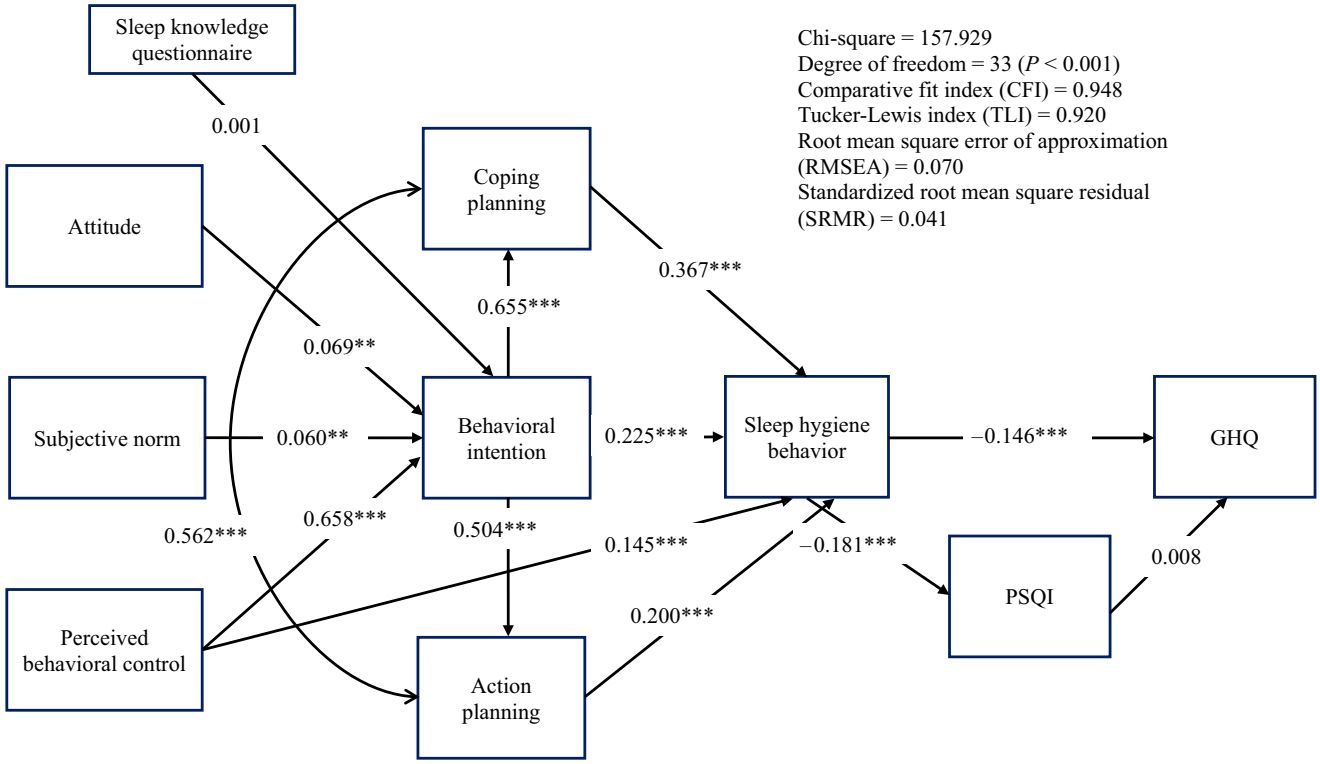

Figure 2. Age and sex were adjusted for scores of the Pittsburgh Sleep Quality Index (PSQI) and the General Health Questionnaire (GHQ); higher scores of PSQI and GHQ indicate worse sleep quality and health, respectively. Those with good semantic knowledge questionnaire (SKQ) scores [SKQ > medium (score > 7); $n = 773$] were used. *$P < 0.1$; **$P < 0.05$; ***$P < 0.001$.

(Fig. 3). The Wald tests showed additionally that the differences in the coefficients were significant (attitude and intention: $\chi^2_{(1)} = 8.30$; $P = 0.003$) or nearly significant (sleep hygiene knowledge and intention: $\chi^2_{(1)} = 3.15$; $P = 0.08$; sleep quality and psychiatric wellbeing: $\chi^2_{(1)} = 3.83$; $P = 0.05$). Regarding other associations among the TPB variables, coping planning and action planning, they were similar between adolescents with poor sleep and those with good sleep, except for the association between action planning and sleep hygiene behaviour (standardized coefficient = 0.200 for good SKQ group and 0.092 for poor SKQ group; $\chi^2_{(1)} = 11.75$; $P < 0.001$).

DISCUSSION

Our results showed that TPB combined with coping and action planning predicted significantly the sleep hygiene behaviours of adolescents 6 months later. In addition, our SEM model showed that sleep hygiene behaviours were associated with sleep quality and psychiatric wellbeing. Sleep hygiene knowledge, however, did not correlate with behavioural intention, nor did it predict sleep hygiene behaviour, sleep quality and psychiatric wellbeing.

Similar to the findings from other health behaviour domains (Lin *et al.*, 2016; Pakpour *et al.*, 2011), our results showed that TPB accompanied by coping and action planning explained sleep hygiene behaviour well. In addition, both coping and action planning predicted sleep hygiene behaviours significantly 6 months later. Our results correspond with previous studies (Araújo-Soares *et al.*, 2009; Lin *et al.*, 2016; Pakpour *et al.*, 2011), such that coping planning (coefficient = 0.384) had stronger effects than action planning (coefficient = 0.144) on sleep hygiene behaviours. Our findings suggest that the anticipation of barriers—which helps an individual to overcome the obstacles successfully—may be more important for performing a health behaviour such as sleep hygiene than identifying when, where and how to pursue an action. Moreover, in the additional model stratified by sleep hygiene knowledge, we found that the effect of action planning is stronger in adolescents with good sleep hygiene knowledge than those with poor sleep hygiene knowledge. Adolescents with good sleep hygiene knowledge who also plan when, where, how and how often to perform sleep hygiene behaviour can translate intention more effectively into sleep hygiene behaviour, sleep quality and psychiatric wellbeing. These findings can be incorporated into interventions to help adolescents initiate and maintain sleep hygiene behaviours. A previous intervention study found that educating adolescents about the effect of alcohol and drugs, depression and anxiety on sleep over five sessions increased weekend sleep duration in the short term (Kira *et al.*, 2014). Another intervention that included cognitive training focused on relaxation strategies and cognitive restructuring, such as recognizing negative thoughts and

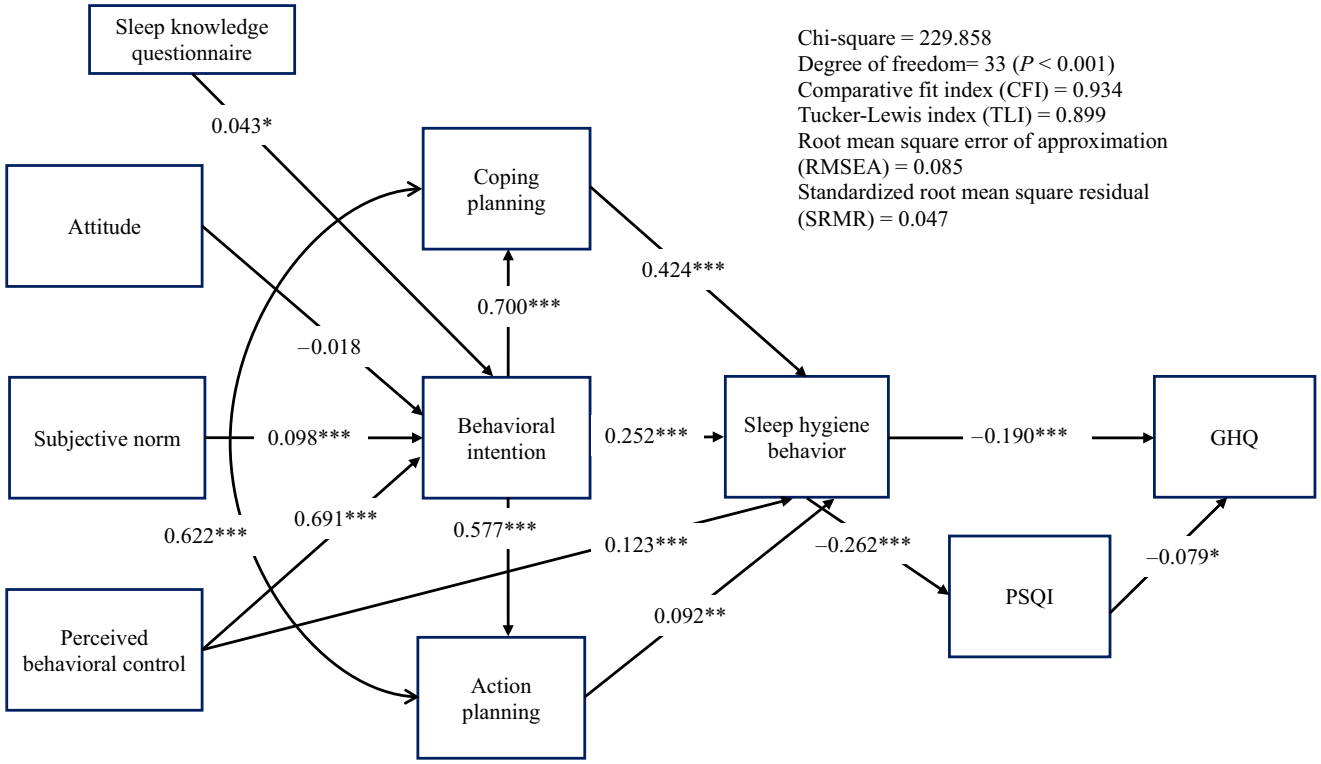

Figure 3. Age and sex were adjusted for scores of thePittsburgh Sleep Quality Index (PSQI) and the General Health Questionnaire (GHQ); higher scores of PSQI and GHQ indicate worse sleep quality and health, respectively. Those with poor semantic knowledge questionnaire (SKQ) scores [SKQ < medium (score < 6); $n = 835$] were used. *$P < 0.1$; **$P < 0.05$; ***$P < 0.001$.

practising replacement thoughts (Hendricks *et al.*, 2014). Because action and coping planning were substantial predictors of sleep hygiene behaviours in our model, we suggest that interventions should further include cognitive training and practice to help adolescents plan for anticipated barriers, and that studies should be carried out to examine the effectiveness in adolescent populations.

Furthermore, our results show that sleep hygiene behaviour is a critical factor that influences the sleep quality and health of an individual (see also Marhefka, 2011; Walker *et al.*, 2010). Healthy sleep hygiene behaviours promote good sleep quality (De Bruin *et al.*, 2014), and help people to recover from daily physical and psychological exertions (Barber and Munz, 2011). Moreover, good sleep hygiene behaviours can prevent an individual from poor sleep quality due to physiopathology (e.g. the intake of caffeine and being excited before sleep). In contrast to our expectation, we did not find any significant relationship between sleep quality and the general health of our participants. Our findings show that although sleep hygiene behaviour correlated directly with psychiatric wellbeing, it did not correlate indirectly via sleep quality. A possible reason is that we measured both sleep quality and psychiatric wellbeing at the same time; thus, the effects of sleep quality on psychiatric wellbeing had not yet occurred. Another possible reason is that we did not recruit adolescents with sleep or major health problems, and the effects of sleep quality on psychiatric wellbeing might be trivial in our largely healthy sample.

We found that sleep hygiene knowledge had no relationship with behavioural intention, and was not correlated with sleep hygiene behaviour and sleep quality in the whole sample. We cautioned that the measurement we used to assess sleep hygiene knowledge had limited psychometric property, an alpha of 0.65, when first developed (Gallasch and Gradisar, 2007). Further, in our analysis of running the original model separately in adolescents who had poor sleep hygiene knowledge and those had good sleep hygiene knowledge, we demonstrated that an interaction effect of sleep hygiene knowledge exists in our model. Sleep hygiene knowledge appears to be associated significantly with behavioural intention only in adolescents with poor sleep hygiene knowledge. Our findings echoed previous research that suggested good sleep hygiene knowledge is associated only weakly with good sleep hygiene practices and does not guarantee good sleep quality (Brown *et al.*, 2002).

Our findings offer some practical insights for health-care providers to foster effective programmes to promote healthy sleep hygiene behaviours for adolescents. For example, sleep hygiene knowledge was associated with behavioural intention only in adolescents with poor sleep hygiene knowledge; therefore, health-care providers may want to emphasize education regarding sleep in this specific population. More generally, however, interventions may benefit by shifting focus to constructing behavioural intentions for the

adolescents, particularly by increasing perceptions of control over sleep hygiene. Furthermore, helping adolescents to identify facilitators and inhibitors of sleep hygiene behaviours may be useful, and helping adolescents to develop plans to cope with common barriers to sleep hygiene. Therefore, motivational interviews that help improve TPB variables (Hardcastle *et al*., 2012) could be used for promoting healthy sleep hygiene behaviour (Cain, 2012).

This study has some limitations. First, the majority of our participants were female, which makes the generalization of our results more representative of females and less for males. Future studies using a balanced ratio between genders are warranted. Secondly, all the participants were healthy. Because sleep quality and health may be related to the illness or disorder of an individual, our results may not be generalizable to adolescents with more serious health issues. However, our findings add to the knowledge of sleep hygiene behaviour in relation to knowledge and perception in the general adolescent population. Thirdly, Patel *et al.* (2010) indicate the relationship between sleep quality, poverty and ethnicity; thus, our results may have limited generalizability to other countries with different economic status or ethnicity from Iran. Studies using data from other countries are therefore warranted. Fourthly, the model fit of the SEM model was only adequate or acceptable, but not satisfactory. There might be other important factors associated with sleep hygiene behaviour, sleep quality and general health that were not considered in our models, which resulted in inadequate model fit. Fifthly, our outcome measures, including sleep hygiene behaviour, sleep quality and general health, were evaluated by self-report 6 months later after baseline data collection; it is possible that some of the variance in self-reported sleep hygiene behaviours could reflect perceived behaviour or response biases rather than actual behaviour, particularly among adolescents who initially had less familiarity with sleep hygiene.

In conclusion, using TPB combined with coping and action planning to design intervention programmes could help providers to address sleep hygiene behaviours and sleep quality in adolescents. However, we did not manipulate TPB variables using an experimental design; future studies are needed to ensure that the changes of TPB variables, including coping and action planning, improve sleep hygiene behaviours, sleep quality and psychiatric wellbeing.

AUTHOR CONTRIBUTIONS

AHP and SJ initiated the study and collected the data. AHP, AB, CS and C-YL analysed and interpreted the data. CS and C-YL wrote the first draft of the manuscript; AHP, JAU and AB critically reviewed the manuscript and provided constructive comments.

CONFLICT OF INTEREST

All the authors declare no conflicts of interest.

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