

ORIGINAL ARTICLE

Waterpipe use in adolescents in Northern Sweden: Association with mental well-being and risk and health behaviours

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Abstract

Aims: There is a lack of studies examining the association between waterpipe smoking and mental well-being among adolescents. This study sought to determine whether waterpipe smoking is associated with mental well-being and other risk and health behaviours in adolescents. **Methods:** A questionnaire was distributed to 1006 adolescents in grades 9–12 (with a response rate of >95%), containing questions on measures of stress, mental energy and sleep. In addition, the questionnaire assessed risk and health behaviours, including use of a waterpipe, cigarettes, e-cigarettes, snus, alcohol, narcotics, gambling and exercise. Logistic regression was used to assess factors associated with waterpipe use. **Results:** Thirty-seven per cent ($n=371$) of the participants had used a waterpipe at some point. Waterpipe use was associated with lower mental energy (odds ratio [OR] = 0.90, 95% confidence interval [CI] 0.81–0.99), higher stress (OR = 1.10, 95% CI 1.02–1.20) and use of cigarettes (OR = 3.82, 95% CI 2.33–6.03), e-cigarettes (OR = 3.26, 95% CI 2.12–4.99), snus (OR = 2.29, 95% CI 2.12–4.99), alcohol (OR = 1.92, 95% CI 1.07–3.44) and narcotics (OR = 3.64, 95% CI 1.75–7.58). Waterpipe use was not significantly associated with gambling, exercise or sleep quality. **Conclusions:** Waterpipe use in adolescents is associated with worse mental well-being, as well as use of other nicotine products, alcohol and narcotics. Prospective studies are needed to delineate causal and temporal relationships further between waterpipe use and mental well-being and its relationship to other risky behaviours in order to design effective prevention programs.

Keywords: Hookah/shisha, e-cigarette, snus, risk behaviour, high-school students

Introduction

Waterpipe smoking is a growing public-health challenge, especially among adolescents [1,2]. While cigarette smoking has decreased considerably due to effective policies and prevention strategies, use of alternative nicotine-containing products such as waterpipes, e-cigarettes and snus (a moist powdered tobacco product) are on the rise [3–6]. The prevalence of current waterpipe use in adolescents is even higher than current cigarette use, according to studies from the USA, Germany, South Africa and the Philippines [7–9].

Nicotine-free alternatives are also being used under the presumption that they are healthier alternatives. According to previous studies, smoking nicotine-free alternatives also has serious health implications, since the smoke produced by these products still contains toxic substances [10–12].

Considering the rise in waterpipe use [2], it is important to determine whether it is associated with other risk and health behaviours in order to be able to handle this public-health challenge more effectively. A growing number of studies have reported an

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Date received 14 September 2016; reviewed 5 November 2017; accepted 9 November 2017

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DOI: 10.1177/1403494817746534

journals.sagepub.com/home/sjp

association between waterpipe use and cigarette smoking [1,13,14]. A few studies have also found that waterpipe use in adolescents is related to other risk behaviours, including use of e-cigarettes [15], snus, alcohol and narcotics [16], as well as gambling [17]. Although waterpipe smoking has been associated with risky health behaviours and can also lead to nicotine dependence [18,19], no prior studies have determined whether such behaviour is also associated with adolescents' mental well-being. Prior work focusing on cigarette smoking suggests that consumption of nicotine is associated with mental well-being, such as perceived stress, mental energy and sleep quality [20–22]. All of these variables have been associated with lower mental well-being [23]. However, no studies examining the association between mental well-being and waterpipe smoking have been conducted.

Lack of involvement in healthy behaviours such as exercise has previously been linked to cigarette smoking in adolescents [24]. In a study of adults, cigarette smoking was inversely associated with the ability to exercise due to the heavy exposure to carbon monoxide after smoking. Carbon monoxide intake leads to decreased blood oxygen carrying capacity which in turn decreases the individual's physical capacity [25]. No such studies exist in relation to waterpipe smoking, although it also involves exposure to high volumes of carbon monoxide [10].

Waterpipe smoking is a potentially unhealthy and dangerous behaviour in adolescents, and it may be associated with other risk and health behaviours. Jessor [26] proposed a conceptual model, which provides a general explanatory framework for adolescent risk behaviour. According to his model, five interrelated domains with risk and protective factors are associated with risk behaviours, which are in turn associated with various health and personal outcomes [26]. In contrast, Arnett [27] suggested that unhealthy behaviours in adolescents are predominantly associated with sensation seeking, egocentrism and the socialisation influences of family and friends.

The aim of the current study was to examine the associations between waterpipe use and mental well-being, as well as the use of cigarettes, e-cigarettes, snus, narcotics, gambling and exercise among adolescents.

Methods

Participants

Participants came from a purposeful sample of four schools in Umeå, Sweden. Purposive sampling is used to identify participants based on certain predetermined criteria related to the objective of the

study. In this study, a homogeneous sample of adolescent high-school students, aged 16–19 years, was recruited.

The research team approached the school superintendent with the support of the Umeå municipality, which governs the schools, and obtained permission to conduct the survey. Potential participants were met in their classrooms and were verbally informed about the research project. Prior to data collection, the parents had been informed about the study through the schools' web pages. However, the participants were never formally informed about when the data collection was to take place, prior to meeting them in their classrooms, so there was no risk of their absence from classes in order to skip participation. The study included 1006 respondents (57% boys, 41% girls and 2% with other affiliations, representing a response rate of >95%), aged between 16 and 19 years, attending school grades 9–12. Non-respondents were only those students who were absent from class during the data collection, estimated at 5% of each respective class.

Data collection

Data were collected in 35 classrooms during regular school hours. Members of the research team introduced the questionnaire to students in each classroom and remained until the questionnaires were completed and returned. The questionnaire did not contain any personal identifiers, and in an effort to safeguard confidentiality, students were only asked to report which school they attended, not which class. The questionnaire instrument used was an adapted Swedish version of one used in a prior US waterpipe study [28], and had been tested in the Swedish setting in a pilot study [29].

Questionnaire measures

Demographic variables. The survey included questions on gender and school grade (class 9, 10, 11 or 12) which was used as a proxy for age. Academic performance was assessed using the question, 'How was your most recent grade point average (GPA)?', with responses 'below average', 'average' and 'above average'.

Mental well-being. We assessed mental well-being with three separate validated items, which assessed stress, mental energy and sleep quality, respectively. Each was measured using a visual analogue scale from 1 to 10. Higher scores indicated higher stress, higher mental energy and better sleep. Thus, stress was rated from 1 (not at all stressed) to 10 (very stressed).

Mental energy was rated from 1 (very low energy) to 10 (very high energy) and sleep quality was rated from 1 (very poor) to 10 (very good). These three separate visual analogue scales have been validated in prior studies using more comprehensive Likert-type survey instruments that contain several items assessing each of the above constructs [30–32]. The mental-energy measure was developed to assess a person's rating of his own energy using a visual analogue scale [30,31,33,34]. Most scales measuring depression are focused on assessing lack of energy or behaviours that are impaired due to lower energy levels. The energy scale has been validated in prior studies by confirming its predictive and construct validity using the Hospital Depression and Anxiety scales [33]. Studies on fatigue have assessed the correlation between responses on single-item visual analogue scales for measures of mental energy and sleep quality and other Likert-type scales. These were based on Cohen's criteria where the correlations were considered moderate to strong in comparison to other multi-item Likert scale measures (0.44–0.91; $p=0.001$) and a strong correlation to other single item measures (0.91–0.94, $p=0.001$) [34]. Other researchers have validated the use of single-question visual analogue scales when assessing stress, which was reported to be significantly correlated (Lin's concordance coefficient=0.66) to that of more commonly used measures like Cohen's Perceived Stress Scale [35,36].

Risk and health behaviours. Waterpipe smoking was assessed using the question, 'Have you ever smoked a waterpipe?', with four response alternatives: 'never', 'tried/tested', 'sometimes' and 'often'. Ever having used cigarettes ('Have you ever smoked cigarettes?'), e-cigarettes ('Have you ever smoked e-cigarettes?'), and snus ('Have you ever tried snus?') were all assessed with the same four response alternatives. In the analysis, respondents stating 'never' to waterpipe use were classified as non-users. Respondents stating they had tried/tested a waterpipe or smoked a waterpipe sometimes or often were considered waterpipe users. In further analysis, we considered those reporting sometimes/often as regular users. Similarly, for use of cigarettes, e-cigarettes and snus, those having tried/tested, sometimes or often were classified as users, and those who had responded 'never' were classified as non-users.

Alcohol use was assessed with the question, 'Have you ever tested any type of alcohol?', with responses 'yes' or 'no'. Similarly, gambling was assessed using the question, 'Have you ever gambled?', with responses 'yes' or 'no'. Participants were also asked if they ever participated in sports/exercise during their leisure time, with responses 'yes' or 'no'.

Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics for Windows v22 (IBM Corp., Armonk, NY). Waterpipe use was used as the outcome variable. Chi-square analysis was used to assess group differences on categorical variables and to test for trends in waterpipe use with increasing school grade and academic performance. Independent-samples *t*-tests were used to compare waterpipe users and non-users on continuous variables, including stress, mental energy and sleep quality. A four-step hierarchical logistic regression analysis was used to assess whether mental well-being was associated with waterpipe use, even when controlling for the different risk and health behaviours. Step 1 in the analysis included only demographic variables (i.e. gender, school grade (proxy for age), school and academic performance). In step 2, the three nicotine-related behaviours – use of cigarettes, snus and e-cigarettes – were included in the model. In the third step, the risk and health behaviours – use of alcohol, use of narcotics, gambling and sports/exercise – were added. In the fourth and final step, the mental well-being variables – mental energy, stress and sleep quality – were added to the equation. Nagelkerke r^2 was used to examine the variance explained in waterpipe use for each step. Statistical significance was set to a two-sided *p*-value of <0.05 .

Ethical considerations

The Institutional Review Board of Uppsala University determined that the study did not fall under the Swedish rules requiring approval by an Institutional Review Board (DNR 2014/464). The school administration, potential participants and teachers received verbal and written information about the research goals and the requested time period to conduct the study. Parents were informed via the schools' website, since all participants in the study were >15 years of age and could make their own informed decisions. The study complied with the Declaration of Helsinki. Access to the survey material and data from the study were confined to the research team. All participation was voluntary, and the participants were informed that they could stop taking the survey at any time without any explanation or consequences.

Results

Descriptive characteristics of all study variables based on waterpipe use status are presented in

Table I. Characteristics of the participants by waterpipe use.

Study variables	All participants (N=1006), <i>n</i> (%)	Waterpipe users (N=371; 37%), <i>n</i> (%)	Non-users (N=635; 63%), <i>n</i> (%)	χ^2	<i>df</i>	<i>p</i> -Value
Gender						
Male	568 (57)	213 (58)	355 (56)	0.388	1	0.5
Female	418 (41)	151 (41)	267 (42)			
Other	16 (2)	5 (1)	11 (2)			
School grade						
Grade 9	191 (19)	29 (8)	162 (26)	85.49	1	0.000
Grade10	328 (33)	98 (26)	230 (36)			
Grade 11	235 (23)	107 (29)	128 (20)			
Grade 12	251 (25)	137 (37)	114 (18)			
Academic performance						
Above average	313 (32)	98 (26)	215 (34)	8.57	1	0.000
Average	613 (61)	235 (64)	378 (60)			
Below average	73 (7)	35 (10)	38 (6)			
Ever used cigarettes						
Yes	498 (49)	321 (87)	177 (28)	322.2	1	0.000
No	508 (51)	50 (13)	458 (72)			
Ever used e-cigarettes						
Yes	251 (25)	183 (49)	68 (11)	186.5	1	0.000
No	755 (75)	188 (51)	567 (89)			
Ever used snus						
Yes	458 (46)	296 (80)	162 (25)	278.1	1	0.000
No	548 (54)	75 (20)	473 (75)			
Ever used alcohol						
Yes	692 (69)	346 (93)	346 (55)	155.2	1	0.000
No	314 (31)	25 (7)	288 (45)			
Ever used narcotics						
Yes	120 (12)	105 (28)	15 (2)	149.9	1	0.000
No	886 (88)	266 (72)	620 (98)			
Ever engaged in gambling						
Yes	387 (39)	190 (51)	197 (31)	40.3	1	0.000
No	619 (61)	181 (49)	438 (69)			
Engaged in sports/exercise						
No	762 (76)	231 (30)	531 (70)	40.7	1	0.08
Yes	243 (24)	140 (58)	10 (42)			

Table I. Overall, 37% of students were waterpipe users, and 63% had never smoked a waterpipe. Approximately 15% of participants reported smoking sometimes or often and were considered regular users. Waterpipe ever use was least common in grade 9 students, increased in grades 10 and 11, and was most prevalent in grade 12 ($p < 0.001$ across grades). Above-average academic performance was significantly less common among waterpipe users (26%) than it was among non-users (34%; $p < 0.001$). Fifty-eight per cent of waterpipe smokers who used multiple tobacco products had initiated their nicotine consumption by smoking cigarettes, while 8% of those who had used multiple tobacco products had initiated nicotine use by smoking a waterpipe (these latter results are not shown in Table I).

A greater percentage of waterpipe users used cigarettes, e-cigarettes, snus, alcohol and narcotics, and gambled ($p < 0.0001$) in comparison to non-waterpipe

users. Among waterpipe users, the majority had smoked cigarettes (87%) and had used snus (80%) and alcohol (93%). Waterpipe users participated in sports less than non-users, although this difference did not reach statistical significance (Table I).

Comparisons of stress, mental energy and sleep quality between waterpipe users and non-users are summarised in Table II. Stress was significantly higher among waterpipe users than non-users, while mental energy was significantly lower. Moreover, waterpipe users rated their sleep quality to be significantly worse compared to non-users.

Results of the hierarchical logistic regression are summarised in Table III. The demographic variables gender, school grade (proxy for age), school and academic performance were entered in step 1. School grade was positively associated and academic performance was negatively and significantly associated with waterpipe use. The demographic variables alone accounted for 12.2% of the variance in waterpipe use.

Table II. Self-reported stress, mental energy and sleep quality in waterpipe users and non-users ($n=1006$).

Scales	Waterpipe users			Non-users			<i>t</i>	<i>p</i> -Value	95% confidence interval
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>			
Stress	369	5.74	2.40	630	4.96	2.32	-5.09	0.000	-1.1 to -0.4
Mental energy	369	6.15	2.06	634	6.81	1.84	-5.08	0.000	-0.9 to -0.4
Sleep quality	368	5.72	2.09	635	6.29	2.17	4.21	0.000	0.3-0.8

Scoring: higher scores reflect more stress, better mental energy and better sleep quality.
SD, standard deviation.

In step 2, the smoking-related variables cigarette, e-cigarette and snus use were added, increasing the overall explained variance to 51%. Compared to non-users, the odds of having ever used a waterpipe was four times greater for students who had ever smoked cigarettes (odds ratio [OR]=5.35, 95% confidence interval [CI] 3.41–8.37), more than two times greater for those who had ever used e-cigarettes (OR=3.73, 95% CI 2.49–5.60) and almost two times greater for those who had ever used snus (OR=2.68, 95% CI 1.76–4.09). When smoking-related variables were added to the model, academic performance was no longer significantly associated with waterpipe use.

Other health-related variables including gambling, use of alcohol and narcotics, as well as engaging in sports/exercise, were introduced in step 3. The addition of these variables increased the overall explained variance to 54%. The likelihood of waterpipe use was nearly doubled among students who had ever used alcohol (OR=1.96, 95% CI 1.10–3.49), and was three times greater among those who had ever used narcotics (OR=4.02, 95% CI 1.95–8.30). Engaging in gambling as well as in sports/exercise were not significantly associated with waterpipe use. Use of cigarettes, e-cigarettes and snus remained significantly associated with waterpipe use, even after the addition of the other health-related behaviours. However, the odds of having ever used cigarettes among waterpipe users compared to non-users decreased from 5.35 in step 2 to 4.10 in step 3.

In the final step, mental health-related factors, including stress, mental energy and sleep quality, were added. Higher stress (OR=1.11, 95% CI 1.02–1.20) and lower mental energy (OR=0.90, 95% CI 0.81–0.99) were significantly associated with waterpipe use after controlling for other variables. Sleep quality was not significantly associated with waterpipe use. Use of cigarettes, narcotics, e-cigarettes, snus and alcohol remained significantly associated with waterpipe use. The addition of the mental-health variables in the final step increased the overall variance by about 1% compared to the earlier step.

Due to the strength of the associations between waterpipe use, other risk behaviours and mental well-being, additional analyses were conducted to examine the associations for those who used a waterpipe on a regular basis. In a chi-square analysis, regular users were compared to never and ever users. The proportion of regular users increased significantly from grade 9 (3%, $n=5$) to grade 12 (36%, $n=55$; $p<0.001$). Analyses also revealed associations with regard to use of cigarettes, e-cigarettes, snus, alcohol, narcotics and gambling with regular use of a waterpipe ($p<0.001$). Of note, regular waterpipe use was significantly associated with decreased participation in sports/exercise: 84% of non-users exercised compared to 53% of regular users ($p<0.001$). Analyses of variance with post hoc tests using Bonferroni were also conducted to examine group differences for stress, mental energy and sleep quality based on regular waterpipe use. Regular waterpipe users reported significantly higher stress ($M=5.64$, $SD=2.58$) than non-users ($M=4.96$, $SD=2.32$; $p<0.01$), significantly lower mental energy ($M=6.04$, $SD=2.07$) than non-users ($M=6.81$, $SD=1.84$; $p<0.001$) and significantly lower sleep quality ($M=5.57$, $SD=2.24$) than non-users ($M=6.29$, $SD=2.05$; $p<0.001$; results are not shown in the tables).

Discussion

The aim of this study was to examine the associations between waterpipe use and mental well-being, while also considering risk and health behaviours among adolescents. According to the results presented in Table II, waterpipe users reported higher stress, lower mental energy and poorer sleep quality than non-users and were significantly more likely to have ever used other nicotine-containing products, alcohol, and narcotics, as well as to have engaged in gambling (according to the results presented in Table I). These associations were enhanced among those using a waterpipe on a regular basis.

Conducting logistic regression in four distinct steps, with mental well-being variables added in

Table III. Summary of hierarchical logistic regression analysis for variables associated with waterpipe use.

Variable	Step 1			Step 2			Step 3			Step 4		
	β	SE	OR	β	SE	OR	β	SE	OR	β	SE	OR
Gender	-0.94	0.14	0.91	0.21	0.17	1.23	0.34	0.19	1.41	0.10	0.21	1.12
School grade	0.57***	0.08	1.77	0.56***	0.11	1.75	0.45***	0.11	1.57	0.41***	0.11	1.51
School	-0.09	0.10	0.92	0.04	0.12	1.04	0.06	0.13	1.06	0.03	0.13	1.03
Academic performance	-0.52*	0.26	0.60	-0.07	0.32	0.94	-0.11	0.32	0.90	0.02	0.33	1.02
Ever used cigarettes				1.68***	0.23	5.35	1.41***	0.24	4.10	1.34***	0.25	3.82
Ever used snus				0.99***	0.22	2.68	0.80***	0.22	2.21	0.83***	0.23	2.29
Ever used e-cigarettes				1.32***	0.21	3.73	1.22***	0.21	3.37	1.18***	0.22	3.26
Engaged in gambling							0.18	0.20	1.20	0.21	0.21	1.24
Ever used alcohol							0.67*	0.30	1.96	0.65*	0.30	1.92
Ever used narcotics							1.39***	0.37	4.02	1.29***	0.37	3.64
Engaged in sports/exercise							-0.13	0.25	0.88	-0.20	0.25	0.82
Stress scores										0.10*	0.04	1.11
Mental energy scores										-0.11*	0.05	0.90
Sleep quality scores										-0.03	0.05	0.98
Nagelkerke R²	0.12			0.51			0.54			0.55		
χ^2 for step	92.07***			456.58***			490.27***			504.48***		

Variables in step 1: gender, school grade, school, and academic performance; variables in step 2: cigarette use, snus use, e-cigarette use; variables in step 3: engagement in gambling, alcohol use, narcotics use, engagement in sports/exercise; variables in step 4: stress scores, mental energy scores, sleep quality scores.

* $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$.

SE: standard error; OR: odds ratio.

the final step, made it possible to tease out the role of other factors in adolescent waterpipe use. School grade, a proxy for student age, was significantly associated with waterpipe use in all four steps, with an increased likelihood of using a waterpipe in higher grades. Although academic performance was initially inversely associated with ever using a waterpipe, it was no longer significant when considering other tobacco-related products, suggesting that academic performance may not be an independent predictor of waterpipe use in adolescents.

In the final model, higher stress and lower mental energy were both associated with a higher likelihood of using a waterpipe. Sleep quality, while significant in the univariate analysis, was the one mental well-being variable that was not significant in the multivariate analysis. The use of other nicotine-containing products was the most important predictor of waterpipe smoking according to the results presented in Table III, step 2. While higher stress and lower mental energy were factors in waterpipe use, the odds ratios for waterpipe use were highest for use of narcotics, cigarettes and e-cigarettes.

This is the first study to explore the association between mental energy and waterpipe use. Given that adolescents commonly suffer from low mental energy, indicative of lower mental well-being [37], the finding is of concern. Our study shows that waterpipe users also suffer from worse sleep

quality compared to non-users, although not when controlling for other risk and health behaviours. The causal relationship between poor sleep and waterpipe use is not known. However, a prior study in adolescents suggests that nicotine in cigarettes contributes to worse sleep quality [38]. Considering that exposure to nicotine during an average waterpipe smoking session of 45 min is much higher compared to cigarette smoking [39], the potential effects of waterpipe use on sleep may be heightened. However, it is also possible that poor sleep quality promotes a form of self-treatment among adolescents in the form of smoking a waterpipe that acts as a stimulant, like other nicotine-containing products.

Thirty-seven per cent of participants reported having ever used a waterpipe, while 15% smoked on a regular basis, indicating that waterpipe use was quite common in this sample of Swedish adolescents. The results are in line with previous studies, where a quarter of adolescents had smoked a waterpipe at some point [1]. The high prevalence of waterpipe use may be attributed to the novelty of the product which attracts users, as well as the generalised misconceptions about health risks associated with this form of tobacco use [40]. Waterpipe use increased with higher school grades, in line with previous studies showing an increasing use pattern from middle school years through high school [41,42]. The legal age at which tobacco can

be purchased is 18 years in Sweden, and students in the last two years of high school are aged ≥ 18 years. Thus, 11th and 12th graders in high school have easier access to tobacco products, which might explain the higher utilisation rate.

Higher stress was also a risk factor for waterpipe use when controlling for all other risk behaviours. Studies on waterpipe use in university students have reported that increased smoking frequency and inability to quit are more pronounced among those who feel stressed [43,44]. One reason for this could be that stressed adolescents use waterpipes as a means of coping, as nicotine intake among adolescents is associated with stress relief [20]. However, relief from stress evaporates quickly after the termination of smoking [20]. Therefore, with increased stress, smokers tend to increase their nicotine consumption, thereby contributing to the risk for addiction [20]. Additionally, waterpipe smoking is a social event done in the company of peers [40]. Adolescents seek social support from their friends at the time of stress. Although peer support may be protective for stress, adolescents may also get exposed to negative coping strategies including waterpipe smoking at these times [45].

In line with previous studies, our results also show that waterpipe use is associated with cigarette smoking [14,46,47] and ever using e-cigarettes in adolescents [15,47]. However, previous studies have not simultaneously accounted for other risk behaviours common in this age group. In contrast to our study, prior studies on e-cigarette use [15,47] failed to account for alcohol use, which is also common in adolescents [48]. Use of snus is a well-known behaviour among Swedish adolescents [49], and our study suggests that users of snus are also more likely to smoke a waterpipe, thus increasing the total exposure to nicotine. Although snus use is known to be predominant among Swedish boys [50], from the results of this study, the notion rises that the use of snus was equally common among boys and girls who used a waterpipe. This may be because waterpipe smoking is a more socially accepted behaviour compared to the use of snus and cigarettes [40]. Also, young girls have been targeted in tobacco marketing linking waterpipe smoking to social desirability, independence and weight control [51], and this may increase the use of waterpipes among girls.

Waterpipe use was associated with use of alcohol and narcotics when adjusting for all the other health and risk behaviours as well as mental well-being. Of note, >90% of waterpipe users also reported using alcohol compared to 55% among non-users of waterpipes. Nearly one-third

of waterpipe users also reported using narcotics compared to only 2% of non-users of waterpipes. Although the cross-sectional design limits our ability to establish causality, these results indicate that a number of risky health behaviours are linked in high-school students. Moreover, we found significant associations between regular waterpipe use and the other risk behaviours except exercise (to which there was an inverse association). One Israeli study among school children aged 12–18 years reported that alcohol and narcotic drugs were added to the waterpipe tobacco in order to enhance the smoking experience [52]. However, the questions in our survey concerned ever using alcohol and narcotics, not necessarily in conjunction with waterpipe smoking.

Although gambling was associated with waterpipe use in univariate analyses, it did not remain significant on controlling for other risk and health behaviours. In line with studies of cigarette smokers [53], our study also found that adolescents who smoke a waterpipe reported lower grades than non-users did. Nicotine intake has been associated with academic disengagement leading to lack of concentration and high stress, which may in turn be related to waterpipe smoking [54].

Considering the health effects of these risky behaviours, our results suggest a need for prospective studies aiming to determine the temporal relationship between mental well-being, waterpipe smoking and other risky health behaviours. The co-occurrence of risky behaviours in adolescents in the current study are in line with Jessor's framework, which suggests that co-occurring risk behaviours may have common underlying risk factors, one or more of which mediate the association between the different risk behaviours [26]. Understanding of the commonly occurring risk factors is considered vital in designing unified and effective intervention strategies against several risk behaviours, especially when they co-occur [26]. Arnett [27] emphasised peer influence, and waterpipe smoking is a social activity done in the company of friends [55]. Peer influence in this case may be a common risk factor for other risk behaviours, thus explaining the co-occurrence with waterpipe smoking. According to Jessor, adolescents who engage in multiple risk behaviours earlier are at an increased risk of developing a syndrome of problem behaviours [26]. This theory may explain how adolescents who may have tested waterpipe smoking since it was more socially acceptable may have subsequently involved themselves in other risk behaviours over time due to disinhibition. However, there are relatively few studies examining the cause–effect relationships between

waterpipe smoking and other risk behaviours [1,14]. Therefore, the directionality of such an association is unclear. In line with previous research, our study also identified clustering of health risk behaviours, together with poor mental health [56,57], which may have also mediated the exposure to several risk behaviours simultaneously. Some studies in the past have shown that adolescents with mental illnesses engage in multiple risky behaviours which act as stimulants or self-medication, giving them some relief from psychological distress [57]. It is suggested that future studies ascertain if waterpipe smoking in combination with the other risky behaviours have a mental-health stimulating or self-medicating effect.

Strengths and limitations

Our study included teenagers from the Swedish city of Umeå. Although this is a cosmopolitan city, utilisation of a purposeful sample may have resulted in participants not being necessarily representative of adolescents in Sweden. However, since waterpipe smoking is becoming increasingly common globally among adolescents [2], and prior data of the novel indicators examined in this study such as mental well-being are limited, we suggest that this study points out areas of interest for more detailed and prospective studies. Our study used self-report data and may have been affected by recall bias. However, based on our previous experience and existing literature on the validity of self-reported accounts of adolescent tobacco use, we believe that the results are reliable [58]. Finally, this study used a cross-sectional design, and causality cannot be established.

The discussions concerning stress as well as sleep and nicotine intake via waterpipe smoking must be interpreted with caution, since we did not specifically ask the participants if they smoked a waterpipe with or without nicotine. However, according to an annual national report by the Swedish Council for Information on Alcohol and Other Drugs (CAN), adolescents more commonly smoked waterpipe products containing nicotine [41].

Future longitudinal studies need to define the temporal and cause-and-effect relationships better in order to design and evaluate effective countermeasures in adolescence, an age where lifelong adverse health behaviour typically is established.

Conclusion

Waterpipe use is associated with worse mental well-being, including lower mental energy and higher

levels of stress. Furthermore, waterpipe smoking is associated with the concurrent use of other harmful substances, including cigarettes, e-cigarettes, snus, alcohol and narcotics. Future studies should determine the temporal and directional pattern of the above findings by using prospective data. Adolescent waterpipe prevention programs, along with those for other products such as e-cigarettes, cigarettes, snus, alcohol and narcotics, should also consider addressing mental health, as well as the common risk factors associated with these risk behaviours.

Acknowledgements

We would like to extend our gratitude to the school authorities in Umeå for their support of the study. We also thank the students from the respective schools for offering their time to participate in this study.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: The Public Health Agency of Sweden (Folkhälsomyndigheten) provided funding for this research (Grant no. 1059/2014-6.2).

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