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Cultivating a Healthy Living Environment for Adolescents in Post-COVID Era in Hong Kong: Exploring Youth Health Needs

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Abstract: Studies have shown adolescents with higher exposure to health risks than in the past and Hong Kong adolescents are no exception particularly with social crisis in 2019 then COVID-19 pandemic since 2020. Data from health care services for children and adolescent are only hitting the tip of clinical iceberg and creating health profile including living habits, lifestyles, data on health status and health services utilisation is needed to reflect the youth health needs for effective service planning and cultivation of a healthy living environment. An exploratory study on secondary school students was conducted in one district of Hong Kong with potential and resources to become a healthy city. Students were found to have high prevalence of poor sleep quality and quantity, excess screen time, physical inactivity, insufficient intake of healthy diet, emotional disturbance including symptoms of post-traumatic stress disorders (PTSD), not regular attendance of student health services. Multivariate analysis has shown that excessive time on social media websites, short sleeping hours, symptoms of PTDS and lack of regular exercise were independently associated with emotional distress. The youth service providers should work closely with families and school to provide a user-friendly service meeting the youth needs and cultivate a living and learning environment supportive for healthy youth development.

1. Background and Introduction

Prior to the COVID-19 pandemic, the level of well-being among students (school and college) were already a big concern as we are still observing high prevalence of those youth risk behaviors in many countries both east and west [1-5]. Studies have shown adolescents with higher exposure to health risks than those in the past. Therefore, adolescent health should be accorded higher priority on public health policies [6-8]. Accordingly, the 45th session of the UN Commission on Population and Development has chosen Adolescents and Youth as its central theme [9]. Since then, the Covid-19 outbreak has made further significant impact on the mental health, education, and daily routine of students. The changes in daily routine including lack of outdoor activity, disturbed sleeping patterns, social distancing have affected the mental well-being of the students [10]. The decline in the level of physical activity and the prolonged use of electronic media, with increasing effects on students' learning, concentration, and sleep pattern (going to bed late and getting up late) has been observed [11]. Studies have also found increasing prevalence of obesity [12-13] and myopia [14] among school children due to longer screen times, lack of physical activity, and living in small, crowded living and learning spaces. Study on tertiary students has found that over 60% experienced increased stress and around 30% experienced moderate to severe levels of depressive symptoms with increasing use of electronic devices and decreases in outside activities positively associated with a higher level of depression severity [15]. Study has reported that 9% had depression and 14% had anxiety, and 25.4% reporting their mental health had deteriorated since the pandemic [16-Choi].

To dampen the negative impacts caused by COVID-19 on adolescence wellbeing, nine potentially protective aspects of youth and family behaviour during the prior month such as physical activity, time spent in nature and outdoors, appropriate screen time, sleep quantity have been identified in longitudinal study [17]. Adolescent health should emphasise on enhancement of the aforementioned protective factors and minimisation of risk factors. Nonetheless, the question remaining was “how should the services be delivered effectively to meet the needs of adolescents” to reach the penultimate goal of health improvement?

For effective delivery of health services for children and adolescents, their voices should be heard, but unfortunately due to the circumstances of being a minor, they are usually represented by adults only, which may not necessarily reflect their best interests and real needs [18]. Evidence has highlighted the importance of including youth experience and voices in planning, delivery, and evaluation of services [19]. School health services of many countries play an active role in preventive care in the form of screening, preventive services and health promotion particularly on mental health [20]. Participatory approach involves children and adolescents focusing on the necessary conditions to reduce risk factors and collaborative services in primary health care, can help to match the needs of children and adolescents [20]. Assessment of their needs is required to reflect their best interests and analysis of their level of health risk behaviours is more relevant than morbidity and mortality data.

Adolescents do not usually perceive their risks of developing chronic conditions as they happen years later so they should be provided data reflecting their immediate risks. Health communications targeting risk perceptions can lead to behaviour change [21]. Studies have shown that interventions successfully changing risk perceptions often results in behavioural change [22–23]. Disease risk perception is a critical determinant of health behaviour [24]. Adolescents’ risk perception can only be enhanced if they know the existence of risk. Study is needed to investigate youth health behaviours under the COVID-19 pandemic to enable planning of interventions under school health services to maximise the participation of adolescents and collaboration of primary healthcare so a healthy living environment can be cultivated conducive for health living.

This study aims to obtain general overview of secondary school students’ health profile including health risk behaviours, lifestyle and health status; health seeking behaviours including utilisation of student health services (SHS) under the COVID 19 pandemic. The findings would be useful reference how we would cultivate better living environment for adolescents in Post-COVID era.

2. Materials and Method

2.2. Study Design

This is a cross sectional study to create school health profile of secondary school students including health risk behaviours, lifestyle factors, health status and utilisation of student health services (SHS) with the use of electronic questionnaire. This study further analyses the association of health status with health risk behaviours, lifestyles, and SHS utilisation.

The study has been approved by Survey and Behaviour Research Ethics Committee (SBRE) of the Chinese University of Hong Kong (SBRE-20-583). The survey was conducted anonymously. The participating schools have obtained consent from parents and students and students’ participation was entirely voluntarily with no adverse repercussion.

2.2. Study Population

The study population is secondary school students (age 11–18) in Kwai Tsing (K & T) District, one of the 18 Districts in Hong Kong (HK) with district population of around 560,000 (about 8% of total HK population).—It is chosen as the district is pioneer in

Healthy City project [25] and has established a framework for medical-social-community model [26]. However, the median monthly income of K&T is among the lowest in Hong Kong. The K&T District is the first district to establish District Health centre in 2019 which is the key government policy to strengthen primary healthcare with provision of nursing and allied health services including social worker to support the primary medical care providers in the district. The findings would reflect the health needs of adolescents living in low socio-economic condition and how the community health initiatives would help to meet the health needs.

2.3. Sample Population

Based on previous studies, the prevalence of students with emotional disturbance was around 25% [3] and students performing regular exercise also around 25% [4]. Sample size of 288 is needed for margin of error of 5% ($n = z^2 \times p(1-p)/e^2$, $z=1.96$ with significance level at 5%, $p=0.25$, population proportion and $e=0.05$, the margin of error $1.96^2 \times 0.5 \times 0.5/0.1^2=288$). Assuming π_0 , the null hypothesis proportion is 0.25, the prevalence of certain health behaviours and health conditions is 25% for one group of students and $\pi=0.35$, higher proportion among another group of students, the sample will be 125 per group giving a power of 80% ($u=0.84$) of significance at 5% ($v=1.96$) ($N=[u \sqrt{\pi(1-\pi)} + v \sqrt{\pi_0(1-\pi_0)}]/(\pi-\pi_0)^2=[0.86 \times 0.46 + 1.96 \times 0.5]/0.15 \times 0.15=125$). Sample of over 300 students is needed.

K & T District is broadly divided into 2 main sub-districts, Kwai Ching and Tsing Yi. According to 2016 Population by Census, the total population and adolescent population (age 10 to 19) is 336,405 and 32,355 in Kwai Ching respectively and 184,167 and 12,579 in Tsing Yi respectively. Cluster stratified sampling was adopted to select 3 secondary schools and 2 secondary schools randomly from Kwan Chung and Tsing Yi respectively to reflect the proportion representation of the population of the two sub-districts. From each school, students from secondary 2 (S2) age around 13-14 and secondary 5 (S5) age around 17 to 18 were selected for study to represent early and late adolescents. S1 students were new to schools and S6 students were busy with public examination so S2 and S5 students would be more appropriate study subjects.

2.4. Study Tools

This study utilises the Hong Kong Student Health Survey Questionnaire (HKSHQ) to measure the health risk behaviours, lifestyle factors, health status are measured. HKSHQ has been used by Centre for Health Education and Health Promotion of the Chinese University of Hong Kong (CHEP) as a system of surveillance of student health status [27] with continuous refinement as a tool for assessing student health status/health related outcomes [11]. Questions were added to report the utilisation pattern of SHS were added.

Questions screening for Post-Traumatic Stress Disorder (PTSD) were included as COVID-19 pandemic had serious repercussion on mental health [16]. Before the outbreak of COVID-19, there was intense social movement in 2019 and generated public mental health crisis with prevalence of 11.2% for depression and 12.8% for probable post-traumatic stress disorder (PTSD) during the heights of the movement in late 2019 [28]. PTDS can be overlooked easily so this study has adopted the four key screen questions to alert the possibility of PTDS to refer for further evaluation [29].

2.5. Data Collection

Letters of invitation were sent out to the schools sampled in March 2021 with information of the study, sample questionnaire and consent reply form. The schools were then provided the link to access the electronic questionnaire for students to complete the questions.

2.6. Data Analysis

Descriptive data from all variables collected by the questionnaires were computed as categorical variables. Data analysis was performed by using SPSS statistics software (version 25.0). The proportions of particular outcomes were tabulated. For certain categorical variables, they were converted to binary variables. The mode of sleep time reported by students is 6 hours so it is used as dividing line. For exercise, the Centre for Health Protection of Hong Kong Special Administrative Region (CHP) recommends doing at least 150–300 minutes of moderate-intensity aerobic physical activity; or at least 75–150 minutes of vigorous-intensity aerobic physical activity; or an equivalent combination of moderate- and vigorous-intensity activity throughout the week, for substantial health benefits in adults [30]. Therefore, more than 60 minutes of moderate to vigorous intensity 3 days per week is used as the dividing line. CHP recommends 5 servings of fruit and vegetables [30] and the mode of fruit and vegetable intake reported in this study is 0.5 serving so 1 serving is used as dividing point. For symptoms of PTSD, those with 2 symptoms are classified as positive to allow higher level of alertness [29]. For screen time, 2 hours is chosen as dividing line as American Academy of Paediatrics has advised not more than 1 to 2 hours for children [31]

The Chi-square test was used to analyse differences among dichotomous dependent variables at the 5% levels of significance. Multiple logistic regression was utilised to identify the independent variables associated with emotional distress (feeling sad and hopeless seeking help from others).

3. Findings

A total of 585 students with 120 and 159 male students and 134 and 172 females students from S2 and S5 respectively, participated in the study from 5 secondary schools randomly selected by stratified cluster sampling as described in previous section.

Table 1 shows the prevalence of different living habits (sleeping time and quality, time spent on electronic media), lifestyles (diet and exercise), health status (emotional health, symptoms suggestive of PTSD), and utilisation of student health services. Around 30% of students slept less than 6 hours per day with poor quality. Nearly half spent over 2 hours on television, electronic games and social media platform. Most students had very poor consumption of fruits and vegetables with 1 serving or less and low level of regular exercise (Table 1). Over 20% of students felt emotional distress affecting daily activities and over 40% felt the need to seek help. Nearly 20% of students had symptoms suggestive of PTDS. However, nearly 80% of students did not attend student health services regularly. The prevalence of self-reporting substance misuse was found to be very low, 0.2%.

Figure 1 shows the reasons of sleep disturbance. The four main reasons reported are failing to fall asleep within 30 minutes, nightmares, waking up midnight or early morning, and hot environment. There is significant association between sleep quality and sleeping hours with 77.9 % of those sleeping 6 hours or above and only 48.5% of those sleep less than 6 hours rating their sleep quality being good ($P < 0.001$). There is also significant association between sleeping hours and time spent on social media with 78.5 % of those sleeping 6 hours or above and only 63.1% of those spending less than 2 hours on social media ($P < 0.001$). In table 1, we have observed high proportion of students spending a lot of time on screen and reporting emotional disturbance. This would be related to sleeping hours and quality of sleep.

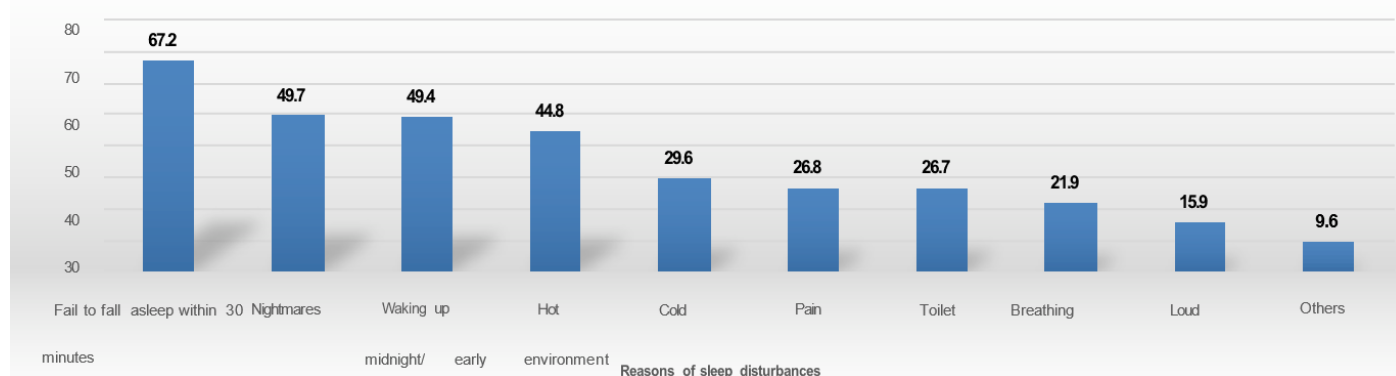
Table 1. Prevalence of living habits, lifestyles, health status (N= numbers of students responding to that question with valid answer).

	Prevalence () number of students	N
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Sleeping < 6 hours daily	28.3% (151)	533
Poor quality of sleep	33% (176)	533
Watching TV > 2hours daily	55% (293)	533
Electronic games > 2 hours daily	56.7 (302)	533
Time on social media website > 2hours daily	42.5% (227)	533
< 1 serving vegetables daily	65.3% (308)	472
< 1 portion of fruit daily	55.9% (327)	585
60 minutes of regular moderate or vigorous exercise-3 days or more per week	31.9% (170)	533
Not having breakfast everyday	61.5% (328)	533
No regular attendance of Student Health Services	77.3% (412)	533
Feeling hopeless and hopeless seeking help from others	42.4% (226)	533
Emotional distress affecting usual activities	22.4% (131)	585
Self-harm	8.9% (47)	533
Suicide plan	6.4% (34)	533
Substance misuse (taken medication not for medical purpose)	0.2% (9)	585
PTSD (2 symptoms or more)	19.5% (114)	585

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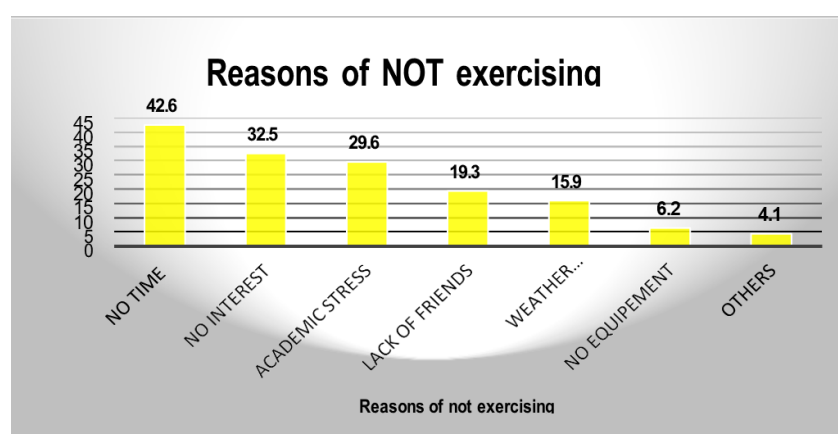
Reasons of sleep disturbances



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Figure 1. Reasons of Sleep disturbances.

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Figure 2. Reasons for not exercising.

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The level of exercise is far from recommended level (Table 1). Figure 2 shows the reasons of not doing regular exercise. The main reasons reported are lack of time (42.6%), no interest (32.5%), academic stress (29.6%) and lack of friends (19.3%).

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Living habits and lifestyles would be correlated with screen time. Table 2 shows the analysis of correlation of screen time (TV, electronic games and social media) with sleeping time, vegetable intake, fruit intake and exercise level. Only time spent on social media website was found to correlate with sleeping time with statistical significance (78.5% of those spending less than 2 hours on social media website had slept 6 hours or more compared with 63.1% of those spending 2 hours or above on social media, $P < 0.001$) (Table 2). Figure 3 shows the perceived impact of screen time on daily life and health. Eye discomforts, effect on study, lack of sleep, loss of concentration was reported as the major issues resulting from prolong screen time.

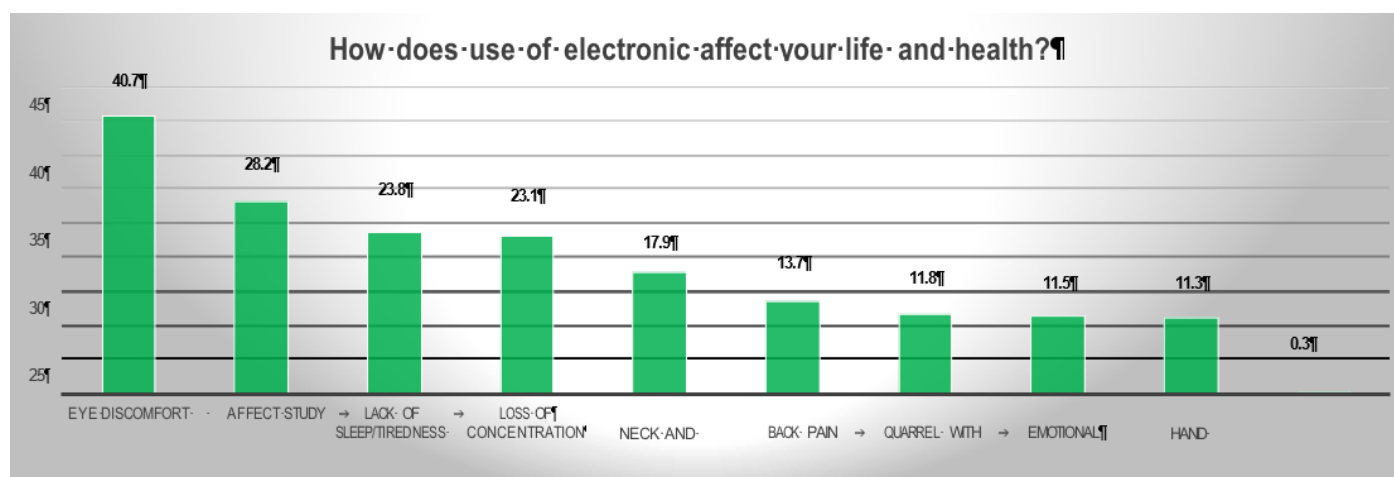


Figure 3. Impact of using electronic media on daily life and health.

Table 1 reveals that students' emotional status is causing concerns (Table 1). Table 3 shows the correlation of emotional status (feeling sad and hopeless and seeking help from others) with living habits, lifestyles, screen time and PTSD. Sleeping time (< 6 hours), low fruit intake (< 1 portion), low level of regular exercise, excess time on social media website and symptoms of PTSD variables were variables found to have significant correlation with emotional status (Table 3).

Table 2. Correlation of time spent on electronic media and living habits.

	Sleep ≥ 6 hours	Sleep < 6 hours	P-value	Vegetable < 1 bowl	Vegetable ≥ 1 bowl	Not sure	P-value	Fruit < 2 servings	Fruit ≥ 2 servings	Not sure	P-value	Exercise < 5 days	Exercise ≥ 5 days	P-value
TV ≥ 2 hours	70.0%	30.0%	0.292	57.3%	32.1%	10.6%	0.944	86.7%	7.2%	6.1%	0.324	86.7	13.3	0.797
TV < 2 hours	73.9%	26.1%		56.2%	32.5%	11.3%		82.2%	9.6%	8.2%		86	14	
Electronic games ≥ 2 hours	69.3%	30.7%	0.103	59.6%	28.9%	11.4%	0.133	86.1%	7.5%	6.3%	0.428	86.4	13.6	0.922
Electronic games < 2 hours	75.4%	24.6%		53.0%	36.8%	10.3%		82.2%	9.5%	8.3%		86.2	13.8	
Social media ≥ 2 hours	63.1%	36.9%	$< 0.001^{**}$	56.2%	32.9%	10.8%	0.962	87.1%	6.4%	6.4%	0.261	83.5	16.5	0.091
Social media < 2 hours	78.5%	21.5%		57.1%	31.8%	11.0%		82.4%	9.8%	7.7%		88.4	11.6	

*** $P < 0.001$.

Table 3. Correlation of emotional status and living habits, lifestyles and health status.

	Feeling sad and hopeless and seeking help from others		N	P value
	Yes	No		
Parental education level both secondary or above	61.2%	73.95	428	0.33
On CSSA	14.8%	21.3%	426	0.17
Sleeping < 6 hours	38.2%	21.1%	584	<0.001***
Sleep quality Poor	39.6%	22.85	580	<0.001***
Vegetable intake < 1 bowel	64.7%	62%	521	0.31
Fruit intake < 1 portion	68.4%	63%	545	0.02*
Not having breakfast everyday	65.1%	59%	585	0.17
Regular moderate or vigorous exercise 3 days or more in a week	26.4%	36.7%	585	0.01**
Watch TV > 2 hours per day	51%	50%	555	0.74
Electronic gamers > 2 hours per day	43.8%	42.5%	585	0.8
Spending time on social media website > 2 hours per day	51.3%	35.5%	585	<0.001***
No regular use of Student Health Services	77.8%	75%	585	0.49
PTDS (2 or more symptoms)	34.5%	7.4%	585	<0.001

*P value<0.05. **P value <0.01. *** P value <0.001.

Logistic regression was performed to identify the independent factors significantly associated with poor emotional status (Table 4). Sleeping less than 6 hours, spending over 2 hours on social media website and PTDS (2 or more symptoms) were independent variables found to have higher odd ratios, 1.62 (95 ci 1.08, 2.42), 1.77 (95 ci 1.23, 2.65) and 5.86 (95% ci 3.6, 9.6) of poor emotional status respectively. Students with regular moderate or vigorous exercise (over 60 minutes over 3 days per week) had lower odds ratio, 0.65 (95% ci 0.44, 0.95) of poor emotional status.

Table 4. Lifestyles and health status significantly associated with emotion feeling sad and hopeless seeking help from others by multivariate analysis.

	Odds Ratio	95% confidence interval	P value
Sleep < 6 hours	1.62	1.08, 2.42	0.018
Regular moderate or vigorous exercise 3 days or more in a week	0.65	0.44, 0.95	0.027
Spending > 2 hours on social media website	1.77	1.23, 2.65	0.02
PTDS (2 or more symptoms)	5.86	3.6, 9.6	<0.001

SHS is key source of preventive care for students in Hong Kong. With the high prevalence of unhealthy living habits and lifestyles, and poor emotional status, the low uptake rate of regular attendance of SHS (77.3%, table 1) should be explored. All primary and secondary students can enrol SHS to receive services meeting the health needs at various stages of their development including physical examination; screening for health problems related to growth, nutrition, psychological health and behaviour; individual health counselling and health education. Figure 4 shows the reasons of not using SHS regularly. Lack of time, unfamiliar with the service, stress over academic work and doubtful of usefulness of the services are the main reasons. For improvement of SHS attendance, 49.7% of students suggested to organise within school hours and 40.7% suggested to organise the service within the school premises.

Figure 4. Reasons for not utilizing Student Health Services

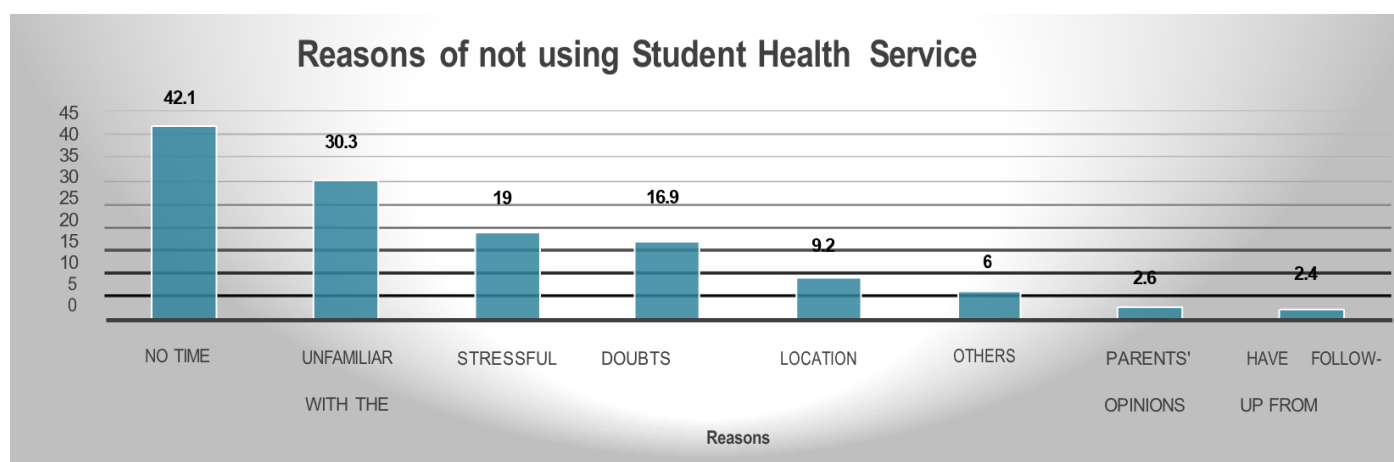


Figure 4. Reasons for not utilizing Student Health Services.

4. Discussion

This study has found inadequate sleeping time among adolescents. The American Academy of Sleep Medicine has recommended sleeping 8–10 hours per 24 hours for teens aged 13–18 years for optimal health [32]. The prevalence of short sleep duration (< 8 hours) among high school students in US national Youth Risk Behaviours Surveillance was 72.7% [33]. Our study shows 28.3% of students sleeping less than 6 hours and 81.5% slept less than 8 hours. Similar patterns were reported in other Asian countries such as Taiwan [34] and Korea [35], and the average duration of sleep was 4.9 hours in Korean study [35]. Adolescent Sleep Working Group has reported that process involved in regulating sleep timing seems to be altered to favour late nights across adolescent development [36]. The Group has also observed the trends of adolescents and young adults growing up in an electronic age and electronic exposure in the evening potentially disrupting sleep [37]. Our study has found high prevalence of media use amongst the students. This is particularly the case under COVID-19 with school closure and electronic media being main channel for communication [11]. Engaging in a greater number and range of sleep-interfering activities such as use of electronic media before going to bed has been shown to associate with less nocturnal sleep and more daytime sleepiness in adolescents [38]. This study has shown higher proportion of students using social media websites less than 2 hours daily with sleeping time over 6 hours with statistical significance (Table 2). Media use can cause increased sleep-disrupting mental, emotional, and physiologic arousal [39]. This might reflect the reasons of sleep disturbance such as failing to fall asleep, nightmares, waking up midnight or early morning (Figure 1) and also the impact of excess screen time such as eye discomforts, effect on study, lack of sleep, loss of concentration (Figure 3).

The prevalence of emotional disturbance was found to be high in this study with 22.4% feeling emotional distress affecting their daily activities and 42.4% feeling sad and hopeless seeking help from others. The prevalence was found to be significantly higher among those with less than 6 hours sleeping time, low fruit intake, low level of regular exercise, excess time on social media website and symptoms of PTSD (Table 3). Table 4 has identified sleeping less than 6 hours, spending over 2 hours on social media website and PTSD (2 or more symptoms) to have higher odd ratios, and regular moderate or vigorous exercise (over 60 minutes over 3 days per week) associated with lower odds ratio analysed by multiple logistic regression. Self-reported sleep variables such as trouble sleeping, tiredness, nightmares, and being a long sleeper have been found to be

significantly associated with psychological symptoms, including anxiety/depression, and withdrawal [40].

Not getting the recommended amount of sleep for their age are at increased risk for chronic conditions such as diabetes, obesity, and poor mental health, as well as injuries, attention and behavioural problems, and poor academic performance [32, 37, 41]. The quality of sleep is related to sleeping hours as this study has found that 51.5% of adolescents reported poor sleeping quality with less than 6 hours sleep compared with 22.1% with 6 hour or more sleep with statistical significance ($P < 0.001$). Sleep quality is just as important as sleep duration in predicting future health which is often overlooked [42]. Evidence has reviewed a very strong evidence tying sleep quality to the development of mental disorders, more than double the risk of depression and anxiety [42].

Study has shown that adolescents spending more than 3 hours per day on social media may be at heightened risk for mental health problems, particularly internalizing problems [43]. Poorer quality sleep can be a mediator on the pathway to internalizing problems [44]. Poor emotion regulation and lack of social interaction may also be associated with social media use and contribute to symptoms of anxiety and depression [45]. However, adolescents may turn to social media as a form of escapism, perhaps for relief of emotional distress. Results of a longitudinal study have revealed that increased time spent on social media was not associated with increased mental health issues across development when examined at the individual level [46]. Emotional problems are multifactorial, involving person centred characteristics such as biological predispositions, coping mechanisms, and situation such as experiencing traumatic events and prolong exposure to stress, sleep.

Time on social media use is an important factor associated as the study by Riehm et al and suggests that if adolescents using social media for more than 30 minutes per day instead used it for 30 minutes or less would have been 9.4% fewer high internalizing problem cases and 7.3% fewer high externalizing problem cases [43]. However, findings from Coyne et al have also suggested examining the context and content surrounding social media use and many other factors that might explain the increase in mental or emotional health problems during adolescence [46]. In this study, we examine other factors such as living habits and lifestyles as well as symptoms of PTSD as independent variables.

Major mental health burden has been identified during COVID pandemic [16] and social unrest in 2019 [28]. Post traumatic growth (PTG) defined as the positive psychological changes upon having to terms with highly stressful events has been found to be more likely among people with higher post-traumatic stress [47]. Students have been under profound impact of social unrest in second half of 2019 [28] then facing the COVID-19 pandemic so the odds of poor emotional status was found to be very high (OR 5.86, 95% CI 3.6, 9.6, table 4) with symptoms of PTSD. Screening for PTSD symptoms would enable early detection of those at risk. Patient education and social support are important initial interventions to engage the patient and mitigate the impact of the traumatic event so rapid engagement of treatment, early and ongoing social support, avoidance of retraumatization, have been shown to associate with good prognosis [48].

A systematic review has found evidence of a significant, cross-sectional relationship between unhealthy dietary patterns and poorer mental health in children and adolescents [49]. In univariate analysis, higher proportion of students with poor intake of fruit was found to feel sad and hopeless (Table 3). The association was not found in multiple regression analysis. It would be overall very high prevalence of poor intake of fruit and vegetable among students (over half taking less than one proportion a day, table 1). Regular exercise has been found to associate with lower odds of having emotional problems with statistical significance in univariate and multi-variate analysis (Tables 3 and 4). Physical activity is well recognised as a key factor for the prevention and management of mental illness, including mental disorders such as depression and anxiety as well as the promotion of mental health such as well-being [50]. Physical activity has been found to

be a good and effective choice to mitigate the negative effects of the COVID-19 pandemic on mental health during the first year of the COVID-19 pandemic [51].

Longitudinal study by Rosen has found association of low passive screen time use, low news media consumption about the pandemic, structured daily routine, and spending more time spent in nature, and getting the recommended amount of sleep with better mental health outcomes in youth during the pandemic [17]. Encouraging more physical activity can also help adolescents to spend more time in nature. Appropriate screen time can improve sleep hygiene and can also have direct effect on mental health. Cultivating positive lifestyles and living habits as well as provision of physical environment conducive for regular exercise and supportive social environment to cope with post-traumatic stress can enhance emotional well-being of adolescents in post COVID era. The home and school environment should empower the adolescents to adopt more structured daily routine, regular exercise and access to resources for emotional support. The Adolescent Sleep Working Group has reported the evidence strongly implicating earlier school start times (i.e., before 8:30 AM) as a key modifiable contributor to insufficient sleep, as well as circadian rhythm disruption [36]. Starting time for school would be further explored to enable students to have sufficient sleep both quantity and quality.

The mental health burden among adolescents is of serious concerns and is expected to increase further with COVID pandemic. The low level of regular utilisation of SHS will not enable the service to play an active role in preventive care particularly health promotion including mental health [20]. Lack of participation of students cannot allow the services to focus on the necessary conditions to reduce risk factors and match the needs of children and adolescents [20].

There are limitations of this study. Self-reporting might not capture all the data. However, it is the best option not only under COVID-19 and also mobilises co-operation of youth, Cross sectional study cannot investigate the causal relationship. The findings of association would still be useful to plan future longitudinal study. It is only based on one district in Hong Kong. The K&T district is chosen for a particular reason. The district is pioneer in healthy city movement and also first district with government commissioned District Health Centre. The findings can be useful reference to help the district to strengthen the primary healthcare services to target the needs of adolescents. The existing experience and culture of healthy city movement together with the infra-structure of District Health Centre, the K&T district has the potential to evolve a new model of comprehensive adolescent care which is user friendly.

5. Conclusion

The findings of this study reflect the unmet needs of students and provide some insights of types of services to serve their best interests. Services for adolescents should be more integrated to promote better living environment for maintenance of healthy behaviours. A systemic review has identified key components of user-friendly youth services [52]. These include accessibility, staff being supportive, respectful and trustworthy with active listening and clarity of information, perceived medical competency, assurance of privacy, confidentiality and patient autonomy, comprehensive and continuity of care, youth involvement in healthcare, age-appropriate environment, and health outcomes focusing on quality of life. The services should be based in the locality where the adolescents live and study. The service providers need to establish a good rapport and trust with the adolescents as well as cultivating a living environment conducive for positive youth health. Local family doctors and the local District Health Centre are in unique position to work and engage the key stakeholder, adolescents, the families, schools and other local youth services to deliver youth friendly services.

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Informed Consent Statement: School consent was obtained from each participating school.

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References

- Sidebotham, P.; Fraser, J.; Covington, T.; Freemantle, J.; Petrou, S.; Pulikottil-Jacob R.; Cutler, T.; Ellis, C. Understanding why children die in high-income countries. *Lancet* 2014; 384 (9946): 915-927.
- Elgar, F.J.; Pfortner, T.K.; Moor, I.; De Clercq, B.; Stevens, G.W.; Currie, C.; Socioeconomic inequalities in adolescent health 2002-2010: a time-series analysis of 34 countries participating in the Health Behaviour in School-aged Children study. *Lancet* 2015; 385 (9982):2088-95. doi: 10.1016/S0140-6736(14)61460-4.
- Lee, A.; Keung, V.; Lo, A.; Kwong, A. Healthy School environment to tackle youth mental health crisis. *Letter to Editor. Hong Kong Journal of Paediatric* 2016; 21 (2): 134-5
- Lee, A.; Keung, V. Epidemics of Childhood Obesity amongst Chinese students and effectiveness of school-based intervention. *Health Education Monograph Series* 2012; 29(1): 37-46.
- CDC. Youth Risk Behaviour Surveillance 2019-United States. *MMWR* 2019; 69 (SS-01).
- Catalano, R.F.; Fagan, A.A.; Gavin, L.E.; Greenberg, M.T.; Irwin, C.E Jr.; Ross, D.A.; Shek DT. Worldwide application of prevention science in adolescent health. *Lancet* 2012; 28;379(9826):1653-64. doi: 10.1016/S0140-6736(12)60238-4.
- Gore, F.M.; Bloem, P.J.; Patton, G.C.; Ferguson, J.; Joseph, V.; Coffey, C.; Sawyer, S.M.; Mather, C.D. Global burden of disease in young people aged 10-24 years: a systematic analysis. *Lancet* 2013;377(9783):2093-102. doi: 10.1016/S0140-6736(11): 60512-6.
- Patton, G.C.; Coffey, C.; Cappa, C.; Currie, D.; Riley, L.; Gore, F.; Degenhardt, L.; Richardson, D.; Astone, N.; Sangowawa, A.O.; Mokdad, A.; Ferguson, J. Health of the world's adolescents: a synthesis of internationally comparable data. *Lancet* 2012; 379(9826):1665-75. doi: 10.1016/S0140-6736(12)60203-7.
- Editorial. Putting adolescents at the centre of health and development. *Lancet* 2012; 379: 1561.
- Chaturvedi, K.; Vishwakarma, D.K.; Singh, N. COVID-19 and its impact on education, social life and mental health of students: A survey. *Child and Youth Services Review* 2021; 121, [10.1016/j.childyouth.2020.105866](https://doi.org/10.1016/j.childyouth.2020.105866)
- Lee, A.; Keung, V.M.W.; Lau, V.T.C.; Cheung, C.K.M.; Lo, A.S.C. Impact of COVID-19 on Life of Students: Case Study in Hong Kong. *Int J Environ Res Public Health* 2021; 6;18(19):10483. doi: 10.3390/ijerph181910483. PMID: 34639783; PMCID: PMC8508172.
- He, M.; Xian, Y.; Lv, X.; He, J.; Ren, Y. Changes in body weight, physical activity, and lifestyle during the semi-lockdown period after the outbreak of COVID-19 in China: An online survey. *Disaster Med. Public Health Prep.* 2021, 15, e23-e28
- Jenssen, B.P.; Kelly, M.K.; Powell, M.; Bouchelle, Z.; Mayne, S.L.; Fiks, A.G. COVID-19 and changes in child obesity. *Pediatrics* 2021, 147, e2021050123.
- Wang, J.; Li, Y.; Musch, D. C.; Wei, N.; Qi, X.; Ding, G.; Li, X.; Song, L.; Zhang, Y.; Qi, X.; et al. Progression of myopia in school-aged children after COVID-19 home confinement. *JAMA Ophthalmol.* 2021, 139, 293-300.
- Fong, B.Y.F.; Wong, M.C.S.; Law, V.T.S.; Lo, M.F.; Ng, T.K.C.; Yee, H.H.L.; Leung, T.C.H.; Ho, P.W.T. Relationships between physical and social behavioural changes and the mental status of homebound residents in Hong Kong during the COVID-19 pandemic. *Int. J. Environ. Res. Public Health* 2020; 17:6653. doi: 10.3390/ijerph17186653.
- Choi, E.P.H.; Hui, B.P.H.; Wan, E.Y.F. Depression and Anxiety in Hong Kong during COVID-19. *International Journal of Environmental Research and Public Health*. 2020; 17(10):3740. <https://doi.org/10.3390/ijerph17103740>
- Rosen, M.L.; Rodman, A.M.; Kasperek, S.W.; Mayes, M.; Freeman, M.M.; Lengua, L.J.; Meltzoff, A.N.; MaLaughlin, K.A. Promoting youth mental health during the COVID-19 pandemic: A longitudinal study. *PLoS ONE* 2021; 16(8): e0255294
- Zdunek, K.; Alma, M.; van Til, J.; Groothuis-Oudshoorn, K.; Boere-Boonekamp, M.; Alexander, D. "Listening to Young People", Blair, M., Rigby, M. and Alexander, D. (Ed.) *Issues and Opportunities in Primary Health Care for Children in Europe*, Emerald Publishing Limited, Bingley: 2019 pp. 55-76. <https://doi.org/10.1108/978-1-78973-351-820191008>
- Anderson, J. E.; & Lowen, C. A. Connecting youth with health services: Systematic review. *Canadian Family Physician* 2010; 56(8): 778-784.
- Jansen, D., Vervoort, J.P.M., Visser, A., Reijneveld, S.A., Kocken, P., de Lijster, G. and Michaud, P.-A. (2019), "School Health Services", Blair, M., Rigby, M. and Alexander, D. (Ed.) *Issues and Opportunities in Primary Health Care for Children in Europe*, Emerald Publishing Limited, Bingley, pp. 219-236. <https://doi.org/10.1108/978-1-78973-351-820191015>

21. Noar, S.M.; Zimmerman, R.S. Health Behavior Theory and cumulative knowledge regarding health behaviours: are we moving in the right direction? *Health education research* 2005; 20(3):275–290.
22. Sheeran, P.; Harris, P.R.; Epton, T. Does heightening risk appraisals change people's intentions and behavior? A meta-analysis of experimental studies. *Psychological Bulletin* 2014; 140:511.
23. Schmälzle, R.; Renner, B.; Schupp, H.T. Health Risk Perception and Risk Communication. *Policy Insights from the Behavioral and Brain Sciences*. 2017;4(2):163-169. doi:[10.1177/2372732217720223](https://doi.org/10.1177/2372732217720223)
24. Ferrer, R.; and Klein, W.M. Risk perceptions and health behaviour. *Curr Opin Psychol* 2015; 5: 85-89
25. Lee, A.; Nakamura, K. Engaging diverse community groups to promote population health through Healthy City approach: Analysis of successful cases in Western Pacific Region. *Journal Environmental Research and Public Health* 2021; 18, 6617. <https://doi.org/10.3390/ijerph18126617>
26. Lee, A.; Chow, Y.H. Health-promoting Healthcare Organisations: Hong Kong Case Studies. In Lee A (ed). *Healthy Setting Approach in Hong Kong: Sustainable Development in Population Health*. City University of Hong Kong Press, 2021, pp131- 146.
27. Lee, A.; Tsang, K.K. Youth risk behaviour in a Chinese population: a territory wide Youth Risk Behavioural Surveillance in Hong Kong. *Public Health* 2004;118(2):88-95.
28. Ni, M.Y.; Yao, X.I.; Leung, K.S.M.; Yau, C.; Leung, C.M.C.; Lun, P.; Flores, F.P.; Chang, W.C.; Cowling, B.J.; Leung, G.M. Depression and post-traumatic stress during major social unrest in Hong Kong: a 10-year prospective cohort study. *The Lancet* 395 (10220): 273-284,
29. Creamer, M.; McFarlane, A. Post-traumatic stress disorder. *Australian Prescriber* 1999; 22:32-4.
30. Centre for Health Protection. Non-Communicable Diseases and Healthy Living. Hong Kong Special Administrative Region. <https://www.chp.gov.hk/en/healthtopics/25/index.html> Access 26 April 2022
31. American Academy of Paediatrics. Children, Adolescents and Television. *Paediatrics* 2001; 107(2): 423-426.
32. Paruthi, S., Brooks, L. J., D'Ambrosio, C., Hall, W. A., Kotagal, S., Lloyd, R. M., Malow, B. A., Maski, K., Nichols, C., Quan, S. F., Rosen, C. L., Troester, M. M., & Wise, M. S. (2016). Consensus Statement of the American Academy of Sleep Medicine on the Recommended Amount of Sleep for Healthy Children: Methodology and Discussion. *Journal of clinical sleep medicine* 12(11), 1549–1561. <https://doi.org/10.5664/jcsm.6288>
33. Wheaton, A.G.; Jones, S.E.; Cooper, A.C.; Croft, J.B. Short Sleep Duration Among Middle School and High School Students — United States, 2015. *MMWR Morb Mortal Wkly Rep* 2018;67:85–90.
34. Huang, Y.S.; Wang, C.H.; Guilleminault, C. An epidemiologic study of sleep problems among adolescents in North Taiwan. *Sleep Med*. 2010;11(10):1035–1042
35. Yang, C.K.; Kim, J.K.; Patel, S.R.; Lee, J.H. Age-related changes in sleep/wake patterns among Korean teenagers. *Pediatrics*. 2005;115(suppl 1):250–256
36. Adolescent Sleep Working Group;. Committee on Adolescence;. Council on School Health. School start times for adolescents. *Pediatrics*. 2014;134(3):642–649. doi:10.1542/peds.2014-1697
37. Owens, J. Adolescent Sleep Working Group; Committee on Adolescence. Insufficient sleep in adolescents and young adults: an update on causes and consequences. *Pediatrics*. 2014; 134(3):e921-32. doi: 10.1542/peds.2014-1696.
38. Eggermont, S.; Van den Bulck, J. Nodding off or switching off? The use of popular media as a sleep aid in secondary-school children. *J Paediatr Child Health*. 2006;42(7–8):428–433
39. Cain, N.; Gradisar, M. Electronic media use and sleep in school-aged children and adolescents: a review. *Sleep Med*. 2010;11(8):735–742
40. Coulombe, J.A.; Reid, G.J.; Boyle, M.H.; Racine, Y. Concurrent associations among sleep problems, indicators of inadequate sleep, psychopathology, and shared risk factors in a population-based sample of healthy Ontario children. *J Pediatr Psychol*. 2010;35(7):790–799
41. Lowry, R.; Eaton, D.K.; Foti, K.; McKnight-Eily, L.; Perry, G.; Galuska, D.A. Association of sleep duration with obesity among US high school students. *J Obes* 2012;2012:476914.
42. Bin, YS. Is Sleep Quality More Important Than Sleep Duration for Public Health?. *Sleep*. 2016;39(9):1629-1630. doi:10.5665/sleep.6078
43. Riehm, K.E.; Feder, K.A.; Tormohlen, K.N.; et al. Associations Between Time Spent Using Social Media and Internalizing and Externalizing Problems Among US Youth. *JAMA Psychiatry*. 2019;76(12):1266–1273. doi:10.1001/jamapsychiatry.2019.2325
44. Li, X.; Buxton, O.M.; Lee, S.; Chang, A.M.; Berger, L.M.; Hale, L. Sleep mediates the association between adolescent screen time and depressive symptoms. *Sleep Med*. 2019; 57:51-60. doi:10.1016/j.sleep.2019. 01.029
46. Hoge, E.; Bickham, D.; Cantor, J. Digital media, anxiety, and depression in children. *Pediatrics*. 2017;140 (suppl 2): S7 6-S80.
47. Coyne, S.M.; Rogers, A.A.; Zurcher, J.D.; Stockdale, L.; Booth, M. Does time spent using social media impact mental health?: An eight year longitudinal study. *Computers in Human Behavior*, 2020; 104, 106160 <https://doi.org/10.1016/j.chb.2019.106160>
48. Lau, B.H.P.; Chan, C.L.W.; Ng, S.M. Post-traumatic Growth in the First COVID Outbreak in Hong Kong. *Front. Psychol* 2021; 12:675132. doi: 10.3389/fpsyg.2021.675132
49. Grinage, B.D. Diagnosis and Management of Post-traumatic Stress Disorder. *Am Fam Physician* 2003; 68: 2401-8,2409
50. O'Neil, A.; Quirk, S.E.; Housden, S.; Brennan, S.L.; Williams, L.J.; Pasco, J.A.; Berk, M.; Jacka, F.N. Relationship Between Diet and Mental Health in Children and Adolescents: A Systematic Review. *American Journal of Public Health* 2014; 104: e31-42. <https://doi.org/10.2105/AJPH.2014.302110>

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51. Teychenne, M.; White, R.L.; Richards, J.; Schuch, F.B.; Rosenbaum, S.; Bennie, J.A. Do we need physical activity guidelines for mental health: what does the evidence tell us? *Ment Health Phys Act* 2020;18:100315. 506
507
52. Marconcin, P., Werneck, A.O., Peralta, M.; Ihle, A.; Gouveia, É.R.; Ferrari, G.; Sarmiento, H.; Marques, A.. The association between physical activity and mental health during the first year of the COVID-19 pandemic: a systematic review. *BMC Public Health* 2022; 22 (209) <https://doi.org/10.1186/s12889-022-12590-6> 508
509
510
53. Ambresin, A.E.; Bennett, K.; Patton, G.C.; Sanci, L.A.; Sawyer, S.M. Assessment of youth-friendly health care: a systematic review of indicators drawn from young people's perspectives. *J Adolesc Health*. 2013; 52(6):670-81. doi: 511
10.1016/j.jadohealth.2012.12.014. PMID: 23701887. 512
513