Clustering of multiple lifestyle behaviors among migrant, left-behind and local adolescents in China: a cross-sectional study

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Research Article

Keywords: clustering, lifestyle behavior, migration, left-behind, adolescents

Posted Date: December 29th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-126264/v1

Version of Record: A version of this preprint was published on March 19th, 2021. See the published version at https://doi.org/10.1186/s12889-021-10584-4.

Abstract

Background: Influence of migration on externalized behavioral problems (e.g., aggressive) among adolescents has been well assessed, yet lifestyle behaviors of migrant, left-behind and local adolescents have been largely overlooked by researchers and policy-makers. Therefore, this study aimed to identify clustering of multiple lifestyle behaviors and their associations with migrant status among Chinese adolescents.

Methods: A cross-sectional survey was conducted in 2015 in Beijing City and Wuwei County. Adolescents self-reported age, gender, family economic status, migrant situation, and lifestyle behaviors (physical activity, sleep, smoke, drink, fruit and vegetable consumption) via a battery of validated questionnaires. Latent class analysis was conducted to identify behavioral clusters using Mplus 7.1. ANOVA, and multivariable logistic regression were used to examine associations between migrant situations and behavioral clusters using SPSS 22.

Results: Three distinct behavioral clusters were exhibited among 1,364 students (mean age: 13.41±0.84 years): “low risk” (N=847), “moderate risk” (N=412) and “high risk” (N=105). The “high-risk” cluster had the highest prevalence of adolescents not meeting healthy behavioral recommendations. There were no significant differences in the prevalence of high-risk lifestyle among migrant, left-behind, rural local and urban local adolescents. But migrant adolescents had the lowest prevalence of low-risk lifestyle, followed by left-behind, rural and urban local adolescents. Moreover, compared with urban local, migrant (OR=2.72, 95%CI: 1.88,3.94), left-behind (OR=2.28, 95%CI: 1.46, 3.55), and rural local (OR=1.76, 95%CI:1.03,3.01) adolescents had a higher risk of moderate-risk lifestyle.

Conclusions: Clustering of different lifestyles was observed. To achieve the target of a 15% relative reduction in insufficient physical activity by 2030 and to promote health eating, more attention should be paid on the migrant and left-behind adolescents in China.

Background

In China, with the steady increase of rural-to-urban migrant laborer over the past decades, a growing number of rural children and adolescents has been either left at home by one or both parent(s) who cannot afford to bring their families to the cities where they work (left-behind) or relocated to urban areas with their parents (migrant). In 2015, the amount of migrant and left-behind children and adolescents at compulsory education stage has reached 33.86 million, with close to 20.19 million left-behind in rural areas [1]. Similar to their migrant parents, migrant and left-behind children and adolescents are typically socially disadvantaged groups that have been attracted great research interests in the impact of migration on individuals, families, and society in the literature. However, lifestyle behaviors of migrant and left-behind children and adolescents have been largely overlooked by researchers and policy-makers [2].

According to family systems theory [3], parents are known to play an important role in the establishment of a child’s secure attachment relationships, for emotional support, self-regulation, as well as the development of social skills and lifestyle habits [4]. Previously, abundant literature has suggested that the migration status of Chinese children or adolescents and their parents was detrimental to their academic achievements, nutrition, body weight, and mental health. Compared to those adolescents with non-migrant parents, left-behind children or adolescents have had poorer nutritional outcomes, a higher risk of stunting, depression, or anxiety, more self-injuries, and a marginally higher risk of substance use including alcohol, smoking, and any substance use, when they are separated from their parents at a younger age and for a longer time [4, 5]. Similarly, rural-to-urban migrant children or adolescents in China are more vulnerable to mental health problems than local children, including social and separation anxiety, depression, loneliness and low self-esteem [6–8]. In the respect of behavioral health, significant differences have been observed in behavioral problems among migrant, left-behind and local children aged 3–16 years [2, 4]. However, they focused on the internalizing problems (i.e., emotional disturbances including schizoid or depressed, social-withdrawal and somatic complaints) and externalizing behavioral problems (refer to behavioral deficits, such as aggressive, delinquent, etc.). There were no studies so far clustering multiple lifestyle behaviors among migrant, left-behind, urban and rural local children or adolescents, and examining the associations of migrant status with lifestyle behavior clusters.

Adolescence is often considered as an important stage of life. Lifestyle behavioral habits, including physical activity (PA), sedentary behavior (SB), sleep, drink, and diet, are commonly established at this stage and tend to track throughout adulthood [9, 10]. Since research has shown that lifestyle behaviors do not occur in isolation, and combinations of multiple behaviors may contribute more to health or disease prevention than single behavior [11–14], identifying clustering patterns of multiple behaviors among adolescents should be given more public health consideration in order to gain the greatest health benefits among migrant, left-behind, urban and rural local adolescents.

Although there has been a growing number of studies investigating the clustering or cooccurrence of multiple modifiable behaviors among adolescents, few of them were conducted in China [14–23]. Parker et al. [14] systematically reviewed studies published up to May 2018, and identified 36 studies examining clusters of activity-related behaviors among adolescents, as well as socio-demographic characteristics and the modifiable correlates associated with behaviors. The most commonly reported combinations of behaviors are PA and SB (13 studies); or PA, SB and diet (13 studies). The remaining 10 studies investigating the cluster of PA, SB and risk-related behaviors such as smoke and alcohol consumption, but they were typically comprised of older adolescents. Moreover, few studies were found including sleep-related factors into their cluster analysis. As insufficient sleep is a risk factor of chronic diseases [24], sleep duration is crucial for adolescents’ health and should be considered. Chen et al. recently has investigated age and gender difference in the co-existence of PA and SB among 10 to 18 years children and adolescents in Shanghai [15]. However, this study disregarded sleep, diet and other risk-related behaviors such as smoke and drink. Collectively, there were no research examining clustering patterns of multiple lifestyle behaviors among migrant, left-behind, urban and rural local adolescents in China.

To address this research gap, this study aims to examine behavior clusters of abovementioned four groups of adolescents in rural and urban China, and investigate associations between migration status and behavioral clusters. Understanding patterns of behaviors among adolescents with different migrant statuses will help to identify at-risk individuals, inform specific lifestyle behavior change, and further eliminate health inequalities and disparities in the current society.

Method

Data source

Cross-sectional data from the Survey on Child and Adolescent Health Development in China (year 2014–2015) were used for this study. Based on previous studies, Child and Adolescent Health Development Questionnaire was developed and had good reliability and validity [25, 26]. A total of 1,402 young adolescents in their first year of middle school were recruited through convenience sampling from eight public middle schools in Beijing City (schools, N = 4; students, N = 775) and Wuwei County, Anhui Province (schools, N = 4; students, N = 627). We received written informed consent from at least one of parent or guardian for all students participating in the survey. Participants completed questionnaires during class time under the supervision of trained researchers and class teachers. The final sample included 1,364 participants for analysis after removing individuals with over five missing lifestyle behavior variables (N = 38). Study procedures were approved by the Beijing Normal University Ethical Advisory Committee.

Measurements

Social demographic variables

The general part of the questionnaire included questions on the adolescents' age, sex, migrant background, and socioeconomic status (SES). Adolescents were asked to rate the SES of their family using 5-point Likert scale from "1 = very poor" to "5 = very rich". The location of participants' or their parents' hukou registration was self-reported by the adolescents. Those who live together with one parent or both parents in Beijing were considered to have a migrant background. In other words, they were born in a rural area and moved to Beijing with their migrant parents without a Beijing hukou. Rural left-behind adolescents were defined as adolescents who lived in the rural hometown while one parent or both of their parents migrated outside of the county/city/province to work. In total, we distinguished four groups in our sample: migrant rural to urban (MA, N = 421), rural left-behind (LBA, N = 432), urban local (ULA, N = 351), and rural local adolescents (RLA, N = 160, whose parents did not migrate outside of the county/city/province to work). Height and weight were measured objectively for calculating their body mass index (BMI). All participants were required to wear light clothing with no shoes. Continuous BMI values were included in the analysis.

Lifestyle Behaviors

Health-related lifestyle behaviors included fruit and vegetable consumption, beverage and alcohol drinking, playing computer games, PA, smoking, and sleeping.

Fruit and vegetable consumption (eating behaviors). Adolescents were asked to report their intake frequency of fruits (except juice), vegetables and soft drinks over a one-week period prior to the survey with three questions. For example, "During the past week, how many times did you had fruits (except juice)?" Or "how many bottle/cans/cups of sparkling water you drank during the past week?". For each question, we created a binary variable indicating whether the daily intake of fruits, vegetables and soft drinks met healthy guidelines (meet coded as 1/Not meet coded as 0). Based on the nutrition guidelines in China, adolescents eating fruits 7 times or more in the past week were coded as meeting the current healthy dietary guidelines of eating fruit every day (high fruit group), and adolescents with a frequency of consuming vegetables 21 times or more in the past week were grouped as meeting the guidelines of eating vegetables at every meal (high vegetable group) [27]. In addition, the frequency of consumption of soft drinks was split at any or non to create a drinking or not drinking category (drink coded as 0/not drink coded as 1).

Moderate to vigorous physical activity (MVPA). During the past week, the number of days per week participating in MVPA for at least 60 minutes (referring to the physical activities that can speed up the heart rate and make adolescents breathe hard) were obtained from the adolescents. For the analysis, participants were grouped into those that met the guidelines (coded as 1) and those that did not meet the guidelines (coded as 0) based on the threshold value for MVPA of 7 days per week according to the PA guidelines issued by the World Health Organization [28].

Screen time. Time spent on screen-based activities was assessed by the following question: "On average, how long do you spend on computer games or things unrelated to learning every day?" The response alternatives were weekdays: _hours_minutes and weekends_hours_minutes. Considering that adolescents aged 12–17 years old are recommended to limit their screen time (TV, computer, inactive video game playing) to no more than 2 hours per day [29], a 2-hour cut-off was used as most recommendations restrict screen-based activities to approximately 2 hours per day, and this cut-off has also been used in previous relevant studies [30, 31]. Moreover, considering that a previous analysis showed a significant difference in screen time between weekdays and weekends [32], for the present research question, the 2-hour screen time per day threshold was used to classify participants into not meeting (> 2 hours/day, coded as 0) and meeting (≤ 2 hours/day, coded as 1) screen time groups for weekdays and weekends separately.

Sleep behavior. Self-reported sleep duration was collected via the following question: "On a weekday/weekend, how many hours do you sleep every night?" Sleep time was collected in hours and minutes for weekdays and weekends. Given that previous studies showed significant sleep duration differences between weekdays and weekends [33, 34], both weekday and weekend sleep duration were included in the analyses in the present study. For teenagers, 8 to 10 hours was considered appropriate [35]. Finally, categorized measures of sleep duration (appropriate sleep coded as 1, not appropriate coded as 0) were included into the analyses.

Smoking and drinking behaviors. Adolescents reported their smoking and alcohol drinking behaviors in response to two questions: “Have you ever smoked?” and “Have you ever had a drink (beer, red wine or white wine)?”. Responses were categorized into no (coded as 1) or yes (coded as 0), separately.

Statistical analysis

A latent class analysis was performed with the above ten lifestyle indexes as observation variables using Mplus Version 7.1. Ratio difference test was used to test the differences in clusters among adolescents with different migrant status. To further examine the influences of migrant status on behavioral clusters, multiple logistic regression was conducted using IBM SPSS Version 22 (Armonk, NY: IBM Corp.). The cut-off point for statistical significance was established as $p < 0.05$.

Results

Descriptive statistics and variable correlations

As shown in Table 1, a total of 1,364 adolescents with a mean age of 13.41 ± 0.84 years were enrolled including 755 male (56.30%) adolescents, 432 left-behind (31.70%), 160 rural local (11.70%), 421 rural-to-urban (30.90%), and 351 urban local adolescents (25.70%). With respect to the ten lifestyle behaviors, the frequencies of not meeting behavioral guidelines ranged from 3.00% (smoking) to 83.87% (MVPA) among the overall sample. Moreover, the frequencies of not meeting the guidelines ranged from 3.94% (smoking) to 90.05% (MVPA), 5.00% (smoking) to 88.13% (MVPA), from 3.10% (smoking) to 82.42% (MVPA), and from 0.85% (smoking) to 76.07% (beverage drinking) among left-behind, rural local, migrant, and urban local adolescents, respectively. The correlation matrix showed most of the correlations of variables were lower than ± 0.3 (Appendix Table 1). Moreover, the variance inflation factors were all less than 10 (range: 1.00–1.15), suggesting that the association was unlikely to influence the clustering procedure.

Table 1
Demographical characteristics of Chinese adolescents: Survey on Child and Adolescent Health Development in China (Year 2014–2015) (N = 1,364)

Characteristics	Total	left-behind adolescents	migrant adolescents	rural local adolescents	Urban local adolescents
Population (n, %)	1,364(100)	432(31.70)	421(30.90)	160(11.70)	351(25.70)
Age (M, SD)	13.41(0.84)	14.08(0.71)	12.99(0.69)	13.89(0.79)	12.87(0.35)
Gender (n, %) [a]					
Girls	585(43.70)	179(41.44)	157(37.29)	68(42.50)	181(51.57)
Boys	755(56.30)	248(57.41)	256(60.81)	86(53.75)	165(47.00)
Family economic status	3.61(.079)	3.37(0.67)	3.66(0.75)	3.24(0.79)	3.99(0.78)
Body mass index	20.05(3.94)	19.21(3.31)	20.71(4.13)	19.06(3.32)	20.65(3.90)
Lifestyle behaviors (not meeting guidelines) (n, %)					
Fruit eating (n = 1296)	617(45.23)	191(44.21)	239(56.77)	61(38.13)	126(35.9)
Vegetable eating (n = 1264)	1022(74.93)	329(76.16)	316(75.06)	115(71.88)	262(74.64)
Beverage drinking (n = 1319)	741(54.33)	271(62.73)	237(56.29)	92(57.50)	141(40.17)
Moderate to vigorous physical activity (n = 1311)	1144(83.87)	389(90.05)	347(82.42)	141(88.13)	267(76.07)
Weekday screen time (n = 1303)	263(19.28)	109(25.23)	90(21.38)	25(15.63)	39(11.11)
Weekend screen time (n = 1305)	628(46.04)	205(47.45)	224(53.21)	72(45.00)	127(36.18)
Weekday sleep (n = 1315)	506(37.10)	191(44.21)	114(27.08)	78(48.75)	123(35.04)
Weekend sleep (n = 1326)	474(34.75)	151(34.95)	163(38.72)	46(28.75)	114(32.48)
Smoking (n = 1305)	41(3.00)	17(3.94)	13(3.09)	8(5.00)	3(0.85)
Alcohol drinking (n = 1314)	302(22.14)	95(21.99)	84(19.95)	32(20.00)	91(25.93)

[a.] Twenty-four adolescents missed the gender variable (1.76%; five left-behind adolescents, six rural local adolescents, eight migrant adolescents, five urban local adolescents).

Latent Clusters Of Multiple Lifestyle Behaviors Among Chinese Adolescents

Five latent models were set up, representing 1 to 5 latent clusters. The statistical fitting parameters were shown in Table 2. According to the Akaike information criterion (AIC), adjusted Bayesian information criterion (aBIC), the likelihood ratio test (LMR) value, entropy, and the suggestion that the number of participants in the least cluster should be no less than 5%, the model with four or five clusters was not better than the model with three clusters. Judging from the synthesis of various fitting parameters and the theoretical significance and interpretability of the results, it seemed that the model with three clusters was more suitable than the others. For the three-cluster model, the cluster probabilities were 62.10% (n = 847, cluster 1), 30.20% (n = 412, cluster 2) and 7.70% (n = 105, cluster 3). The three-cluster model was relatively suitable for determining comprehensive clusters in terms of practical significance, model simplicity and various fitting parameters.

Table 2
Index of latent classes of multiple lifestyle behaviors: Survey on Child and Adolescent Health Development in China (Year 2014–2015) (N = 1,364)

Class	k	G^2/LL	df	χ^2	AIC	BIC	aBIC	Entropy	LMR	BLRT	Probabilities
1	10	898.58	1025	2283.87	14279.64	14331.84	14300.08				1.000
2	21	659.88	976	1187.43	13863.59	13973.22	13906.51	0.616	< 0.0001	< 0.0001	0.644/0.356
3 [a.]	**32**	**595.86**	**969**	**1125.13**	**13786.73**	**13953.78**	**13852.13**	**0.688**	**< 0.01**	**< 0.0001**	**0.078/0.301/0.621**
4	43	530.44	958	1086.72	13742.33	13966.81	13830.21	0.588	0.1079	< 0.0001	0.072/0.223/0.500/0.206
5	54	484.87	947	926.48	13717.77	13999.67	13828.13	0.635	0.3604	< 0.0001	0.153/0.096/0.112/0.609/0.030

[a.] Bold indicates the final choice for the number of clusters. AIC = Akaike information criterion, BIC = Bayesian information criterion, aBIC = adjusted Bayesian information criterion, entropy indicates classification quality, LMR = *P* value of likelihood ratio test, BLRT = *P* value of bootstrap likelihood ratio test.

Figure 1 showed the percentage of adolescents not meeting the guidelines on the ten lifestyle behaviors in each cluster. Mean differences in the main variables among latent clusters was shown in Table 3. According to the descriptive statistics characteristics of the three latent clusters and the results of Pos hoc, the present study named the three clusters as: (1) The low-risk group (Cluster 1, n = 847), having the smallest proportion of not meeting the guidelines for lifestyle behaviors: with no smoking, short screen time on weekdays, the least alcohol drinking and the most amount fruit eating and vegetable eating. (2) The moderate-risk group (Cluster 2, n = 412), which was relatively less serious, with a lower proportion of adolescents not meeting the behavioral guidelines: less MVPA, spending more screen time, eating less vegetables. (3) The high-risk group (Cluster 3, n = 105): highest prevalence of participants not meeting the behavioral guidelines, especially for smoking and alcohol drinking.

Table 3
Mean differences in the main variables among latent clusters: Survey on Child and Adolescent Health Development in China (Year 2014–2015) (N = 1,364) [a]

	Low-risk (62.11%)		Moderate-risk (30.07%)		High-risk (7.83%)		F	η^2	Pos hoc
	mean	standard deviation	mean	standard deviation	mean	standard deviation			
Fruit eating	0.43	0.5	0.6	0.49	0.26	0.44	21.19***	0.04	2 > 1 > 3
Vegetable eating	0.79	0.41	0.9	0.30	0.61	0.49	15.92***	0.04	2 > 1 > 3
Beverages drinking	0.42	0.49	0.79	0.41	0.84	0.37	129.36***	0.14	3 > 1,2 > 1
Moderate to vigorous physical activity	0.86	0.35	0.95	0.23	0.68	0.47	30.99***	0.04	2 > 1 > 3
Weekday screen time	0.00	0.07	0.58	0.49	0.25	0.44	519.24***	0.43	2 > 3 > 1
Weekend screen time	0.21	0.41	0.96	0.20	0.78	0.41	612.76***	0.48	2 > 3 > 1
Weekday sleep duration	0.34	0.47	0.42	0.49	0.61	0.49	14.50***	0.03	3 > 2 > 1
Weekday sleep duration	0.26	0.44	0.46	0.50	0.66	0.48	49.43***	0.07	3 > 2 > 1
Smoking	0.00	0.05	0.00	0.05	0.35	0.48	286.88***	0.30	3 > 2, 3 > 1
Alcohol drinking	0.13	0.33	0.23	0.42	1.00	0.00	287.07***	0.31	3 > 2 > 1

[a.] In the results of Pos hoc, the risk of high-risk group was more severe due to smoking and alcohol drinking problems compared to the moderate-risk group, though the high-risk group counted three times as the highest score which was same as the moderate-risk group. ***$p < 0.001$.

Disparities in latent clusters of lifestyle behaviors between four group adolescents

As shown in Fig. 2, for the moderate risk cluster, the ratio of MA (37.29%) was higher than LBA (35.19%), RLA (28.75%) and ULA (16.24%). There were significant differences in the ratio of MA, RLA and ULA, as well as the ratio of LBA and ULA ($Zs > Z_{0.001}$). For the low-risk cluster, the ratio of MA (56.29%) was the lowest, followed by the ratio of LBA (57.64%), RLA (61.25%), and ULA (74.93%). Based on the Post Hoc comparison, significant differences were observed between the ratio of ULA and other three groups ($Zs > Z_{0.001}$). In addition, there was no significant difference in the ratios of participants in the high-risk group (cluster 3) among the four groups.

Associations of migrant situations and clusters of multiple lifestyle behaviors

As shown in Table 4, the model 1 was individually tested in separate logistic regression analyses with only age, gender, SES and BMI. Using low-risk cluster as the reference, the results indicated that the probabilities of elder adolescents entering the moderate-risk group (OR = 1.27, 95% CI [1.00, 1.48]) and high-risk group (OR = 1.34, 95% CI [1.04, 1.74]) were higher than young adolescents. Compared to female adolescents, males were more likely to exhibit high-risk behavior (OR = 2.67, 95% CI [1.64, 4.35]). In the model 2, after controlling for the age, gender, SES, and BMI, migrant (OR = 2.72, 95% CI [1.88, 3.94]), left-behind (OR = 2.28, 95% CI [1.46, 3.55]) and rural local adolescents (OR = 1.76,96%CI [1.03,3.01]) were more likely to have moderate-risk lifestyle cluster, compared with urban local adolescents.

Table 4
Multiple logistic regression model for the latent clusters of lifestyle behaviors: Survey on Child and Adolescent Health Development in China (Year 2014–2015)

	Model 1				**Model 2**			
	Moderate-risk vs Low-risk cluster		High-risk vs Low-risk cluster		Moderate-risk vs Low-risk cluster		High-risk vs Low-risk cluster	
	OR	95% CI	*OR*	95% CI	*OR*	95% CI	*OR*	95% CI
Age	1.27*	1.09–1.48	1.34*	1.04–1.74	1.18	0.97–1.43	1.47*	1.05–2.05
Gender (ref. girls)	1.28	0.99–1.65	2.67**	1.64–4.35	1.19	0.92–1.53	2.71**	1.66–4.42
Family economic status	0.92	0.78–1.08	1.20	.90-1.59	0.99	0.84–1.18	1.16	0.87–1.55
Body mass index	1.03	0.99–1.06	1.00	0.95–1.06	1.03	0.99–1.06	1.00	0.94–1.06
Left-behind (ref. Urban local)					2.28**	1.46–3.55	0.68	0.33–1.42
Migrant (ref. Urban local)					2.72**	1.88–3.94	0.82	0.45–1.48
Rural local (ref. Urban local)					1.76*	1.03–3.01	0.83	0.36–1.94

* $p < 0.05$, * *$p < 0.001$.

Discussion

To our knowledge, the present study represents an initial step in understanding how various behaviors blend together to form “overall” healthy or unhealthy lifestyles among Chinese adolescents. And it firstly compares the group differences in behavioral cluster among migrant, left-behind, rural local and urban local adolescents.

Previous studies that explored the relationship between behavioral clusters and sociodemographic correlates usually focused on age, sex, and SES. Cluster patterns were different by age, sex and SES in previous studies [14, 16, 17, 23, 36, 37]. A higher proportion of girls, older children or adolescents, and children/adolescents from the lowest SES in the clusters defined by low levels of PA, high levels of SB or high consumption of beverage drinking [14, 20]. However, studies examining differences in the cluster patterns of behaviors between migrant, left-behind and local adolescents in rural and urban China are limited. Understanding the clustering of “overall” lifestyle behaviors provides a basis to develop tailored interventions that promote effective and sustainable behavior change among this understudied population.

Consistent with previous literature, the present study revealed that adolescents engaged in a variety of lifestyle behaviors, and the cluster patterns were a complex mix of healthy and unhealthy behavioral patterns [14, 18]. All clusters consisted of at least two unhealthy behaviors in current study, which implied that an overall healthy lifestyle was not observed among participants. Therefore, interventions for changing multiple risk lifestyle behaviors simultaneously are needed for adolescents.

Three distinguished behavioral patterns ranging from high risk to low risk were exhibited among young adolescents, with 62% of adolescents having a relatively low-risk lifestyle pattern. The low-risk cluster was characterized by nonsmokers, the lowest levels of screen time, beverage and alcohol consumption, and a moderate level of vegetable consumption and MVPA. One explanation for the lowest levels of screen time in the low-risk cluster may be that only computer time was considered as contributing to screen time in the present study. This is different from other studies which included the time of watching TV or other sedentary behavior-related variables when measuring screen time or overall sedentary time [12, 20, 38]. Therefore, we may have underestimated the screen time of the adolescents in the present study. However, it is worth noting that, with the development of digital technology, computers and mobile phones are increasingly popular for use in adolescent daily life to perform activities unrelated to education. It has been shown that Chinese adolescents usually go online for 22 hours per week to search for information, communicate, and play games [39]. Given the high risk of online information that is unsafe for adolescents, the present study therefore focused on the computer time.

Also, insufficient MVPA and fruit and vegetable consumption were concerns in the high-and moderate-risk clusters. Adolescents in the moderate-risk cluster did not report smoking, but reported the highest level of screen time throughout the week and the lowest level of MVPA and fruit and vegetable

consumption, as well as having moderate levels of sleep and alcohol and beverage drinking. The recommendation for Chinese adolescents is one-piece fruit and three times vegetable each day. However, approximately 60–90% of the adolescents in the moderate-risk cluster reported fewer fruit intake (< 7 times/week) and vegetable intake (< 21 times/week). This implies a critical need to promote fruit and vegetable consumption among young adolescents. In previous studies, the majority of adolescents in Western countries also failed to meet guidelines for one or more health behavior(s); for example, high levels of screen time, low fruit and vegetable consumption, and inactivity tend to cluster in this age group [16, 19, 23]. Although there were differences in the numbers of health-related behaviors, measurements, analytical approaches and countries between the current study and other studies of adolescents, they consistently suggest that behavioral interventions to promote healthy behaviors are challenging, and more studies are required to promote a healthy lifestyle in adolescent population.

Importantly, for the impact of migration on behavioral cluster, the present study found that migrant adolescents had the lowest prevalence of low-risk lifestyle patterns, followed by left-behind, rural local, and urban local adolescent. Moreover, migrant and left-behind adolescents had a significantly higher prevalence of moderate-risk lifestyle than the rural and urban local adolescents. This may partly reveal the potential impact of migration on children. Migration means a change of original living surroundings and adaption to new environments for adolescents. For adolescents who move from rural areas to urban areas with their parents, although they can live with one or both parent(s), adapting to a new school, social and physical environment can be challenging. As for the left-behind adolescents, although they have no difficulties in dealing with a new social environment, living without one or both parent(s) may lead to less parental care or supervision, so as to leading to the emergence of behavioral problems. Accordingly, to promote healthy eating, reducing levels of insufficient physical activities, and screen time, so as to achieve the target of a 15% relative reduction in insufficient physical activity among children by 2030, more attention should be paid on the migrant and left-behind adolescents [40]. As previous studies suggest that disadvantaged parents may have lower health literacy, and are unclear about their own or their child's health risks, so they may not be able to recognize negative changes in their child's emotional health and lifestyle and provide timely support to their children [41, 42]. Health education about the importance of fruits and vegetables, exercise and reduced screen time, as well as the behavioral guidelines for health could be provided to migrant families or guardian stayed with the left-behind and rural local adolescents.

However, different from our hypothesis, the prevalence of rural local adolescents who had high-risk behavioral pattern is slightly higher than migrant, left-behind, and urban adolescents, but there were no significant differences in four groups of adolescents. High-risk behavioral cluster included multiple risk behaviors (e.g., low levels of vegetable consumption, high levels of screen time on weekends, short sleep time throughout the week, smoking, drinking beverages, and alcohol) in current study. The non-significant difference between four groups might be understandable because of the small number of adolescents who had high-risk behavioral cluster. Only 7.83% of adolescents in our study exhibited the high-risk behavioral cluster. This should be further investigated using a larger nationally representative sample.

Limitations and strengths The utilization of latent cluster analysis appears to be a meaningful and useful technique that advances our understanding of health-related adolescent behavior and may provide information for development of tailored interventions for the first time in migrant and left-behind adolescents. However, participants were recruited only from two cities (Beijing vs. Wuwei County) in China and hence cannot be nationally representative, which limits the generalizability of the findings. A second potential limitation of this study was that we were unable to compare the specific roles of migrant fathers and migrant mothers in behavioral development or to comprehensively examine sex disparities in adolescent behaviors. Moreover, this study uses a cross-sectional design, which provides evidence for associations but not for causation. We were also unable to assess the adolescents' behaviors objectively using smartphone or ecological momentary assessment or other real-time monitoring methods because of the following reasons: 1) the students were not allowed to carry mobile phones at school; and 2) lack of accelerometers could be applied all study participants.

Conclusion

In summary, our study concludes that adolescents have multifaceted lives that largely represent a low-risk lifestyle. A single overall healthy lifestyle does not exist in adolescent participants; instead, unhealthy behaviors are usually concomitant, which implies that behavioral interventions are needed and full of challenges. Changing at least two unhealthy behaviors simultaneously is required for adolescents. The clustering of assessed lifestyle behaviors differed by the participants' migrant status and their parents' migrant status. This suggests the potential need for different behavioral intervention targets to reduce risky behaviors in subgroups of adolescents. Particularly, create strategies to promote moderate to vigorous physical activity, and consumption of fruits and vegetables simultaneously in migrant and left-behind adolescents is urgent. There is a need for longer follow-up studies on the behavioral trends of migrant, left-behind and rural local adolescents, and to examine modifiable determinants of different lifestyles among the migrant, left-behind, urban local and rural local adolescents in China, respectively.

List Of Abbreviations

AIC: Akaike information criterion

aBIC = adjusted Bayesian information criterion

BIC: Bayesian information criterion

BLRT: bootstrap likelihood ratio test

LBA: rural left-behind adolescents

LMR: likelihood ratio test

MA: migrant rural to urban adolescents

MVPA: moderate to vigorous physical activity

PA: physical activity

RLA: rural local adolescents

SES: socioeconomic status

SB: sedentary behavior

ULA: urban local adolescents

Declarations

Ethics approval and consent to participate. The study received ethics approval from the Institutional Review Board of the Faculty of Psychology, Beijing Normal University. We received written informed consent from at least one of parent or guardian for all students participating in the survey. All methods were performed in accordance with the relevant guidelines and regulations proposed by the Institutional Review Board of the Faculty of Psychology, Beijing Normal University.

Consent for publication. Not applicable.

Availability of data and materials. The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing Interest: The authors declare that they have no conflict of interest.

Funding: This research was funded by the National Natural Science Foundation of China, Youth Science Foundation (Grant Number 81602869), and the Fundamental Research Funds for the Central Universities (Grant Number 3104221). The funder played no role in study design, data collection or analysis, the decision to publish, or preparation of the manuscript.

Authors' contributions

LH conceptualized the article and contributed to drafting and editing the article. XYL, as co-first author, contributed to the statistical analysis and drafted the article. WDW and YFW contributed to collecting the data and editing the draft. HYQ, YZ contributed to editing the draft. DHL conceptualized the article and contributed to editing the draft. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Acknowledgements

We gratefully acknowledge MW for her contribution to the data collection and data management.

References

1. Ministry of Education of the People's Republic of China. Statistical Bulletin on the Development of National Education in 2016. 2017 July 10; Available from: http://www.moe.gov.cn/jyb_sjzl/sjzl_fztjgb/201707/t20170710_309042.html.
2. Hu HW, Gao JM, Jiang HC. A comparative study of behavior problems among left-behind children, migrant children and local children. Int J Environ Res Public Health. 2018;15(4),655. DOI: 10.3390/ijerph15040655
3. Miller IW, Ryan, CE, Keitner GI. The McMaster approach to families: theory, assessment, treatment and research. Journal of family therapy. 2000;22(2):168-189. DOI: 10.1111/1467-6427.00145
4. Luo J, Zou J., Ji M, Yuan T, Sun M, Lin Q. Emotional and behavioral problems among 3- to 5-year-olds left-behind children in poor rural areas of Hunan province: a cross-sectional study. Int J Environ Res Public Health. 2019;16(21). DOI: 10.3390/ijerph16214188
5. Fellmeth G, Rose-Clarke K, Zhao C. Health impacts of parental migration on left-behind children and adolescents: a systematic review and meta-analysis. Lancet. 2019;392:2567–82. DOI: 10.1016/S0140-6736(18)32558-3
6. Chen L, Su S, Li X. Perceived discrimination, schooling arrangements and psychological adjustments of rural-to-urban migrant children in Beijing, China. Health Psychol Behav Med. 2014;2:713-722. doi: 10.1080/21642850.2014.919865.
7. Wang L, Mesman J. Child development in the face of rural-to-urban migration in China: a meta-analytic review. Perspect Psychol Sci. 2015;10(6):813-831.

8. Zhao C, Wang F, Li L. Long-term impacts of parental migration on Chinese children's psychosocial well-being: mitigating and exacerbating factors. Soc Psychiatry Psychiatr Epidemiol. 2017:52:669–677. DOI: 10.1007/s00127-017-1386-9
9. Liu J, Kim J, Colabianchi N. Co-varying patterns of physical activity and sedentary behaviors and their long-term maintenance among adolescents. J Phys Act Health. 2010;7(4):465-74. DOI: 10.1123/jpah.7.4.465
10. Richter LM. Studying Adolescence. Science. 2006;312(5782): 1902–1905.
11. Agostinis-Sobrinho C, Gómez-Martínez S, Nova E. Lifestyle patterns and endocrine, metabolic, and immunological biomarkers in European adolescents: The HELENA study. Pediatr Diabetes. 2019:20(1):23-31. DOI: 10.1111/pedi.12802
12. Hartz J, Yingling L, Ayers C. Clustering of health behaviors and cardiorespiratory fitness among U.S. adolescents. J Adolesc Health. 2018; 62(5): 583– 590. DOI: 10.1016/j.jadohealth.2017.11.298
13. Saunders TJ, Gray CE, Poitras VJ. Combinations of physical activity, sedentary behavior and sleep: relationships with health indicators in school-aged children and youth. Appl Physiol Nutr Metab. 2016; 41:S283-93. DOI: 10.1139/apnm-2015-0626
14. Parker KE, Salmon J, Costigan SA. Activity-related behavior typologies in youth: a systematic review. Int J Behav Nutr Phys Act. 2019; 16(1):44. DOI: 10.1186/s12966-019-0804-7
15. Chen ST, Liu Y, Hong JT. Co-existence of physical activity and sedentary behavior among children and adolescents in Shanghai, China: do gender and age matter? BMC Public Health. 2018;18(1):1287. DOI: 10.1186/s12889-018-6167-1
16. Collese TS, De Moraes ACF, Fernández-Alvira JM. How do energy balance-related behaviors cluster in adolescents? Int J Public Health. 2019;64(2):195-208. DOI: 10.1007/s00038-018-1178-3
17. Dearth-Wesley T, Howard AG, Wang H. Trends in domain-specific physical activity and sedentary behaviors among Chinese school children, 2004–2011. Int J Behav Nutr Phys Act. 2017;14(1):141. DOI: 10.1186/s12966-017-0598-4
18. Leech RM, McNaughton SA, Timperio A. The clustering of diet, physical activity and sedentary behavior in children and adolescents: a review. Int J Behav Nutr Phys Act. 2014;11:4. DOI: 10.1186/1479-5868-11-4
19. Mandic S, Bengoechea EG, Coppell KJ. Clustering of (Un)Healthy Behaviors in Adolescents from Dunedin, New Zealand. Am J Health Behav. 2017; 41(3):266-275. DOI: 10.5993/AJHB.41.3.6
20. Matias TS, Silva KS, Silva JAD. Clustering of diet, physical activity and sedentary behavior among Brazilian adolescents in the national school-based health survey (PeNSE 2015). BMC Public Health. 2018;18(1):1283. DOI: 10.1186/s12889-018-6203-1
21. Miranda VPN, Dos Santos Amorim PR. Evaluation of lifestyle of female adolescents through latent class analysis approach. BMC Public Health. 2019;19:184. DOI: 10.1186/s12889-019-6488-8
22. NuutinenT, LehtoE, RayC. Clustering of energy balance-related behaviours, sleep,and overweight among Finnish adolescents, Int J Public Health. 2017;62:929-938. DOI: 10.1007/s00038-017-0991-4
23. Pearson N, Griffiths P, Biddle SJ. Clustering and correlates of screen-time and eating behaviors among young adolescents. BMC Public Health. 2017;17:533. DOI: 10.1186/s12889-017-4441-2
24. Nascimento-Ferreira MV, Collese TS, de Moraes AC. Validity and reliability of sleep time questionnaires in children and adolescents: a systematic review and meta-analysis. Sleep Med Rev. 2015;30:85–96. https://doi.org/10.1016/j.smrv.2015.11.006
25. Asher SR, Hymel S, Renshaw PD. Loneliness in Children. Child Dev. 1984;55(4):1456.
26. Centers for disease control and prevention. Methodology of the Youth Risk Behavior Surveillance System-2013. MMWR Recomm Rep. 2013;62(RR-1):1-20.
27. Chinese Nutrition Academy. Dietary Guidelines for Chinese 2016. Beijing: People's Medical Publishing House.
28. World Health Organization. Global recommendation of physical activity for health. April 1,2020. Available from:https://www.who.int/dietphysicalactivity/publications/physical-activity-recommendations-5-17years.pdf?ua=1.
29. Biddle SJH, Pearson N, Salmon J. Sedentary behaviors and adiposity in young people: causality and conceptual Model. Exerc Sport Sci Rev. 2018;46(1):18-25. DOI: 10.1249/JES.0000000000000135
30. Fletcher E, Leech R, Mcnaughton SA. Is the relationship between sedentary behavior and cardiometabolic health in adolescents independent of dietary intake? A systematic review. Obes Rev. 2015;16(9):795-805. DOI: 10.1111/obr.12302
31. Zhai L, Zhang Y, Zhang DF. Sedentary behavior and the risk of depression: a meta-analysis. Brit J Sports Med. 2015;49(11):705-709. DOI: 10.1136/bjsports-2014-093613
32. He L, Zhang XJ, Wang HP. Analysis of the prevalence of screen time behavior among the local and migrant children in Beijing and its influencing factors. Chin J Sch Health. 2018;39(7):1004-1007.
33. Carissimi A, Dresch F, Martins AC. The influence of school time on sleep patterns of children and adolescents. Sleep Med. 2016;33-39.
34. Lin LN, Chang LY, Hurng BS. Sex differences in sleep patterns and changes in 7th to 12th graders: a longitudinal follow-up study in Taiwan. Sleep. 2018;41(3). doi: 10.1093/sleep/zsx211.
35. Hirshkowitz M, Whiton K, Albert SM. National sleep foundation's updated sleep duration recommendations: final report. Sleep Health. 2015;1(4):233-243.

36. Leech RM, McNaughton SA, Timperio A. Clustering of children's obesity-related behaviours: associations with sociodemographic indicators. Eur J Clin Nutr. 2014;68:623-628. DOI: 10.1038/ejcn.2013.295
37. Lee B, Seo DC. Socioeconomic disparities in health risk behavior clustering among Korean Adolescents. Int J Behav Med. 2018;25:540-547.
38. Gorely T, Marshall SJ, Biddle SJ. Patterns of Sedentary Behavior and Physical Activity Among Adolescents in the United Kingdom: Project STIL. J Behav Med. 2007;30(6): 521–531. DOI:
39. China Internet Network Information Center. Research Report on Internet behavior of Chinese teenagers in 2015. Aug.12, 2017. Available from: http://www.cnnic.cn/hlwfzyj/hlwxzbg/qsnbg/201608/t20160812_ 54425.htm.
40. World Health Organization. Global action plan on physical activity 2018-2030: more active people for a healthier world. 2018. Geneva: World Health Organization.
41. Lastrucci V, Lorini C, Caini S, Bonaccorsi G. Health literacy as a mediator of the relationship between socioeconomic status and health: A cross-sectional study in a population-based sample in Florence. PLoS One. 2019;14(12), e227007. DOI: 10.1371/journal.pone.0227007
42. Rajah R, Hassali M, Murugiah MK. A systematic review of the prevalence of limited health literacy in Southeast Asian countries. Public Health. 2019;167:8-15. DOI: 10.6881/AHLA.201810.SK01

Figures

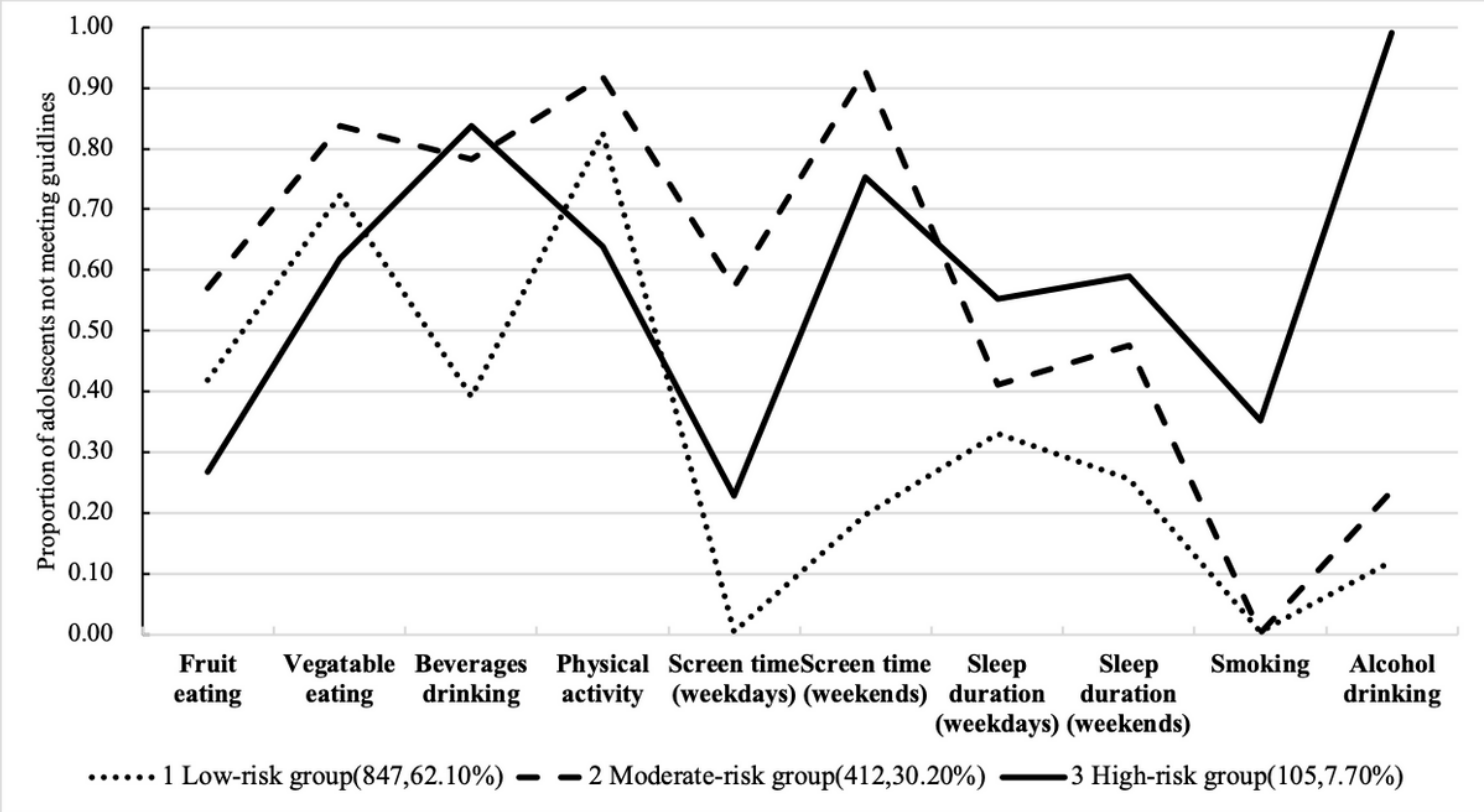

Figure 1

Clusters of multiple lifestyle behaviors among Chinese adolescents: Survey on Child and Adolescent Health Development in China (Year 2014-2015)

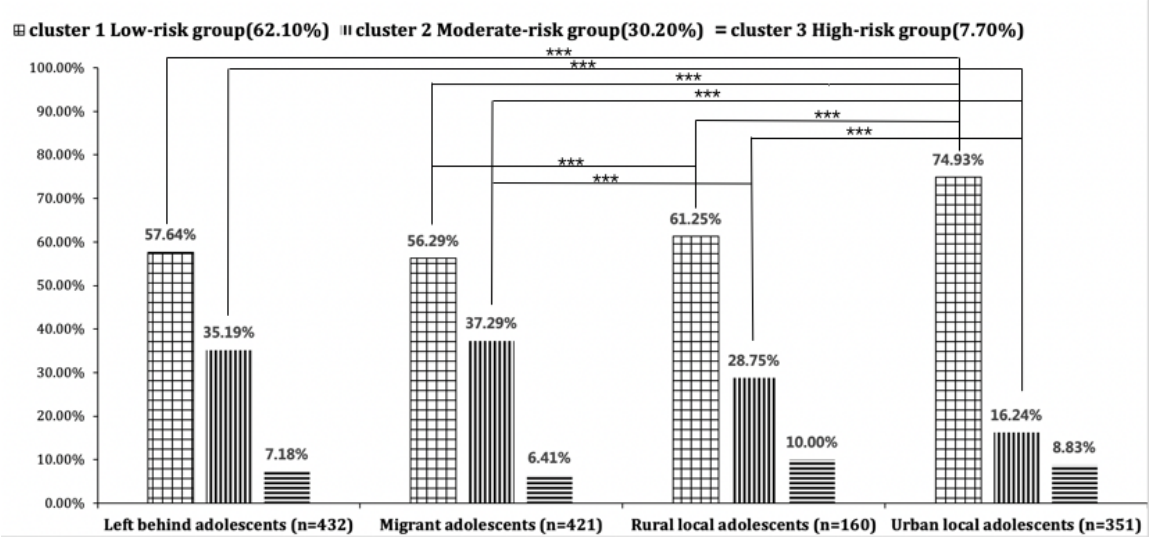

Figure 2

Description of lifestyle behavior clusters by migration status among adolescents: Survey on Child and Adolescent Health Development in China (Year 2014-2015)

Supplementary Files

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- Appendix1.docx