Mental Health Changes and Its Predictors in Adolescents using the Path Analytic Model: A 7-Year Observational Study

Ali Reza Soltanian, PhD[1]
Mohammad Amiri, MD[2]
Soudabeh Namazi, MD[3]
Hossein Qaedi, MSc[4]
Gholam Reza Kohan, BSc [5]

1 Department of Biostatistics & Epidemiology, School of Public Health, Hamadan University of Medical Sciences, Hamadan, Iran
2 Section of Healthy heart, the Persian Gulf Health Research Center, Bushehr University of Medical Sciences, Bushehr, Islamic Republic of Iran
3 Department of Psychologic, Bushehr University of Medical Sciences, Bushehr, Iran.
4 Department of Management and Health Care, School of Public Health, Bushehr University of Medical Sciences, Bushehr, Islamic Republic of Iran.
5 Department of Health, Bushehr University of Medical Sciences, Bushehr, Iran.

Corresponding author:
Ali Reza Soltanian, PhD,
Street of Mahdieh, Lona Park,
Hamadan, Iran.
Tel: +98 811-838-0025
Fax: +98 811-838-0209
Email: a_sultanian@yahoo.com

Objective: This 7-year observational study examines the hours of TV-watching, phone conversation with friends, using the internet, and physical activity as predictors of mental health among adolescents in south of Iran .

Methods: At the baseline (in 2005), the participants were 2584 high school students in the 9th to 11th grade. At the baseline, 30% of the available participants (n = 775) were selected in the follow-up (2012) using convenience sampling method. This study used the path analysis to examine the predictors of mental health and to obtain direct, indirect and total effects of the independent variables.

Results: At the baseline (2005), female gender, internet use, maternal education, physical activity and father's education were associated with mental health (p<0.05). Baseline mental health, internet use and physical activity predicted mental health of the participants in the follow up (p<0.05).

Conclusion: The findings of the study revealed that better mental health in later life is associated with better mental health at baseline, male gender, higher physical activity and phone communication with friends, and less use of the internet and TV.

Keywords: *Mental health, Psychological symptoms, adolescents, Path analysis.*

Psychiatric diseases may lead to several complications in adolescents' people. Psychiatric disorder is ranked second in terms of disease burden based on results of the national burden of disease, and Bushehr provinces had a large rate (1).

In the recent decades, previous studies on the mental health suggested that the prevalence of psychological symptoms among adolescents in Bushehr province is higher compared to other areas of Iran (2-3). This prompted the need to clarify the factors that influence psychiatric symptoms in Bushehr province. Despite the conducted studies (3-6), there is not substantial support for the assumption that the more use of the internet, TV-watching and phone conversation with friends are associated with mental health symptoms in adolescents' later life. It is known that subjective mental health is a complex and multidimensional concept that is not easy to define. Consequently, it will be difficult to determine the

factors associated with mental health. On the other hand, the previous studies have used single-item measures (2-3). Therefore, identifying and recognizing those factors whose effect may change over time such as using the internet, TV, phone conversation with friends, physical activity level and previous mental health status may hardly predict mental health in later years. In addition, most studies on the association between mental health and cultural-socio-economic factors have been cross-sectional (2-7). In other words, cohort studies are useful for disentangling temporal relations, but not necessarily for addressing causality. Several studies have found that the majority of children who are exposed to violence, display psychological symptoms (7-9). The early detection of causal model of mental health in adolescence is of prime importance, because these years are critical for the onset and development of later disturbances (10-16).

In this study, we defined mental health on the basis of four different dimensions of general health: anxiety symptoms, depression symptoms, somatic symptoms and social dysfunction. The main objective of this study was to evaluate the association between using internet, TV watching, phone call, physical activity level and gender on mental disorder symptoms in 2005 and 2012, and also compare predictors of mental disorder symptoms in 2005 and 2012 among Iranian's southern students graded (9-11) For the purpose of the study direct and indirect effects of predictors on the mental health of the participants were examined using the path analysis model. The exogenous and endogenous variables were determined based on the literature (7-18), our own previous studies (2-3) and the preliminary analyses of the data of the present study.

Material and Methods

Sample and Data Set
Data were collected as a part of the Mental Health Study (MHS), which consisted of a series of cross-sectional and prospective studies on mental health of high-school students of Bushehr province (2). The MHS was conducted on 2697 high-school students aged 15-19 years in 2005.Of the participants, 113 dropped out of the study because they did not respond to the questionnaires. Therefore, the final data set included a sample of 2584 high school students in 9th - 11th grade across 8 counties in south of Iran, Bushehr province. The sampling method of the MHS was multi-stage. In the first stage, 51 high schools were proportionally selected based on sex ratio and the number of schools in counties; in the second-stage, some grade of 9-11 were selected randomly, separately; and in the third-stage, the students were selected randomly from name recorded in each class. This data set has been used to examine the predictors of mental health among adolescents in south of Iran. At the baseline (in 2005), 45.6% of the participants were female (n = 1178) and 54.4% were male (n = 1406). About 30% of the available female (n = 353) and male participants (n = 422) were also selected for the follow-up (2012) using convenience sampling method. 30% of subjects were determined based on our budget and facilities. Response rate in the follow-up study (2012) among the male and female participants was 48.4% (n = 171) and 38.9% (n = 164), respectively. In order to collect data, first, we found students' address through the high school offices; second, for those who accepted to participate in the study at the follow-up, their basic data (age, sex, marital status, education, occupation, parent's income, hours of internet use, hours of TV-watching, hours of phone conversation, physical activity level and general health) were inquired by telephone, mail or e-mail based on the baseline questionnaires. Approximately, 87.5% (n = 293) of the participants sent us the filled-out physical activity and GHQ-28 questionnaires by e-mail .

Instruments
In this study, several instruments were used to collect data. The reliability of the instruments was assessed among a sub-sample of 100 high school students. Socio-demographic status was selected based on previous studies (2), 17-18. The instruments are explained as follows:
1. The Socio-Demographic Form (SDF):
The individual and family characteristics of the participants were collected using a form. The socio-demographic variables consisted of age, sex, parent's education, parent's occupation, parent's income, student's grade, time spent with friends (daily), internet use (daily), and TV-watching (daily), which were measured based on continuous scales.
2. 28-item General Health Questionnaire (GHQ-28):
The Persian version of the 28-item general health questionnaire (19) was used to estimate mental health status. GHQ-28 3, 20 is a 28-item self-rating questionnaire addressing a range of psychological symptoms, including anxiety (assessed on a seven item, depression (assessed on a seven item), somatic symptoms (assessed on a seven item), and social dysfunction (assessed on a seven item during). The 28-items general health questionnaire is scored based on a four point Likert-type scale according to a 0-1-2-3 coding system. The minimum and maximum scores of a participant based on the coding system were zero and 84, respectively. The GHQ-28 was translated to Persian by Tehran Psychiatric Institute with Cronbach's alpha of 0.85 on the overall sub-scales (Cronbach's alpha for anxiety, depression, somatic symptoms and social dysfunction sub-scales was 0.81, 0.8, 0.87 and 0.89, respectively).
3. International Physical Activity Questionnaire (IPAQ):
The short-form of the Persian version of the International Physical Activity Questionnaire (IPAQ) (20, 21) was used to determine the levels of physical activity. In the MHS, test-retest was used to obtain the reliability of the Persian version of IPAQ that was 0.79 2. The IPAQ short form assesses three specific types of activity (inactive, minimally and HEPA-active) in the following four domains: a) leisure time physical activity; b) domestic and gardening activities; c) work related physical activity; d) transport- related physical activity (22). Finally, for simplicity we categorized physical activity into a dichotomous indicator (moderate, that was inactive plus minimally; HEPA-active).
Hypothetical Model of Mental Health
The independent variables of the path model and the direction of effects of variables were selected based on the earlier literature (7-9, 10-17), our own previous researches (2-3) and the preliminary analysis of the data of the present study. First, we hypothesized that physical activity, use of internet, TV-watching and phone conversation with friends may be associated with mental health score at the baseline. Second, we presumed that gender would be an underlying factor

which could modify or confound other factors and the association between them. Finally, we supposed that mental health score at the baseline along with other factors such as physical activity, internet use, television watching, phone conversation with friends and gender could predict mental health score in the follow up (2012).

Statistical Analysis
Data were examined for univariate outliers using z scores, mean±3sd. The mechanism of missing data was evaluated by Little's test and there was missing at random system. However, we imputed the missing values using Hot Deck imputation methods. The assumptions of regression model were verified. This study used the path analysis to examine the predictors of mental health and to obtain direct, indirect and total effects of the independent variables. The path analysis models were computed based on Pearson's correlation coefficients between the continuous variables, poly-choric correlation coefficients between the discrete variables and poly-serial correlation coefficients between the continuous and discrete variables. Statistical significance was set at 0.05 and all the tests were two-sided. To assess the fitted model, we examined goodness-of-fit, chi-square and the root mean square error of approximation (RMSEA) (23). All statistical analyses were conducted using R software, release 2.12.1.

Result
The research was conducted on 2584 high school students in south of Iran. The overall prevalence of mental problems was 40.7% (37.9% in males versus 44.1% in females; p = 0.018, Table 1).
Mental Health and its Sub-Scales:
Somatic Distress: This study revealed that 34% of the male and 46.9% of the female participants had somatic distress symptoms in 2005. Seven years later, both male (p = 0.77) and female participants (p = 0.21) reported no significant somatic distress symptoms (Table1). Female students had more somatic distress symptoms than the males at both baseline and follow up.
Anxiety: A high proportion of the participants suffered from anxiety in 2005 and 2012 (Table 1). Anxiety remained unchanged at the same level among both male (p = 0.61) and female participants (p = 0.70) during the seven years follow-up. Females experienced more anxiety symptoms than males in both 2005 and 2012.

Social Dysfunction: Most of the participants reported social dysfunction symptoms at baseline and follow-up (Table1). The study showed that both males (p = 0.004) and females (p = 0.01) reported less social dysfunction symptoms at follow-up. Compared to females, males reported more social dysfunctions at baseline, but there was no gender difference in social dysfunction

symptoms at follow-up .Depression/Suicide: Approximately, 38% of the males and 44% of the females had depression symptoms in 2005. There was no gender difference in depression symptoms at the baseline (p = 0.728, Table 1) and follow-up (p = 0.59). Depression symptoms did not increase among either males (p = 0.18) or females (p = 0.42) during the seven year study period .

Physical Activity: About a half of male and four-sixths of female participants were inactive at the baseline. There was a gender difference in inactive proportion in 2005 (p = 0.003) and in 2012 (p<0.001, Table 1). We did not observe any changes in the inactivity proportion at either male (p = 0.77) or female participants (p = 0.21) at the baseline and follow-up. At the baseline, about 22% of the males and 11% of the females had HEPA-activity. These proportions remained at the same level among both groups during the study period. In other word, the inactivity proportion of the either group did not change during 2005-2012. The male group had more HEPA-activity proportion than the female group in both 2005 and 2012 .

Internet Use: The mean of internet use in the male participants was more than the females in 2005 (p<0.001, Table 1), but there was no gender difference in the internet use at the follow-up (p = 0.29). Hours of internet use significantly increased among both males (p<0.001) and females (p<0.001) during the seven years follow-up .
TV-watching: The average of TV- watching hours among the males was more than the females in 2005 (p<0.001, Table 1), but it was not statistically different between these two groups after the 7-year follow up (p = 0.1). TV-watching hours had a statistically significant decrease among males (p<0.001) during the seven years follow-up, but this decrease was not statistically significant among females (p = 0.53).
Communicating with friends by phone: There was a gender difference in the average of phone conversation with friends both in 2005 (p<0.001, Table 1) and 2012 (p<0.001). Also, we observed that the average of phone call hours increased among both males (p<0.001) and females (p<0.001) during the 7-year follow up.

The Path Analysis Model
The Path analysis model was constructed to examine the associations between the independent variables and mental health at baseline and follow-up. The distributions, means, standard deviations, percentages and differences in independent variables between the two groups of males and females are presented in Table 1. Pearson's correlation coefficients for variables used in constructing the path analysis in 2005 and 2012 are shown in Table 2 and Table 3, respectively.

Table 1: Demographic Characteristics, Status of Physical Activity, Communication Behavior (e.g., hours of internet use, TV-watching, and phone call) and Psychological Symptoms of High-School Students in 2005 and 2012.

Characteristic/Predictors	Baseline (2005, N=2584)			Follow-up (2012, N=335)			P value [b]	P value [c]
	Male (n=1406)	Female (n=1178)	P value [a]	Male (n=164)	Female (n=171)	P value [a]		
Physical Activity n (%)								
Inactive	695 (49.4)	812 (68.9)	0.003	83 (50.6)	126 (73.7)	< 0.001	0.77	0.21
Minimally active	398 (28.3)	218 (18.5)	< 0.001	49 (29.9)	25 (14.6)	< 0.001	0.67	0.21
HEPA-active	313 (22.3)	148 (12.6)	< 0.001	32 (19.5)	20 (11.7)	0.049	0.42	0.75
Mental Health n (%)								
Somatic distress	478 (34)	552 (46.9)	< 0.001	58 (35.4)	81 (47.4)	0.02	0.72	0.90
Anxiety	648 (46.1)	643 (54.9)	< 0.001	79 (48.2)	96 (56.1)	0.04	0.61	0.70
Social dysfunctions	961 (68.3)	739 (62.7)	0.003	95 (57.9)	93 (54.4)	0.52	0.004	0.01
Depression/Suicide	483 (34.4)	397 (33.7)	0.728	65 (39.6)	63 (36.8)	0.59	0.18	0.42
GHQ-28 score ≥ 23	533 (37.9)	519 (44.1)	0.018	68 (41.5)	83 (48.5)	0.19	0.37	0.27
	Mean ± S.d.			**Mean ± S.d.**				
Internet use (hours/day)	1.94 ± 2.42	1.24 ± 2.05	< 0.001	2.97 ± 3.96	2.61 ± 2.14	0.29	< 0.001	< 0.001
TV-watching (hours/day)	3.97 ± 2.33	3.02 ± 2.29	< 0.001	3.58 ± 2.13	3.14 ± 2.71	0.1	< 0.001	0.53
Phone call (hours/day)	0.57 ± 0.39	0.2 ± 0.95	<0.001	1.83 ± 1.92	0.77 ± 1.55	< 0.001	< 0.001	< 0.001

[a] p-value to compare between male and female at both 2005 and 2012 years separately;
[b] p-value to compare measures at base line (2005) and follow-up (2012) in male;
[c] p-value to compare measures at base line (2005) and follow-up (2012) in female.

Table 2: Pearson's Correlation Coefficient between the Selected Variables among all Subjects in 2005(n = 2584)

	1	2	3	4	5	6
1. Sex	1					
2. Physical activity 2005	-0.24*	1				
3. Phone call with Friends 2005 (hours / day)	0.25*	-0.01	1			
4. Internet use 2005 (hours / day)	-0.19*	0.04	0.01	1		
5. TV watching 2005 (hours / day)	-0.28*	-0.09	0.02	0.09	1	
6. Mental health score 2005	-0.61*	-0.40*	-0.51*	0.57*	0.39*	1

*P<0.05.

Table 3: Pearson's Correlation Coefficient between the Selected Variables among all Subjects in 2012 (n = 335)

	1	2	3	4	5	6	7
1. Sex	1						
2. Physical activity 2012	-0.31*	1					
3. Mental health score 2005	-0.44*	-0.40*	1				
4. Phone call with Friends 2012 (hours / day)	0.25*	-0.01	-0.51*	1			
5. Internet use 2012 (hours / day)	-0.10	0.04	0.57*	0.01	1		
6. TV watching 2012 (hours / day)	-0.08	-0.09	0.39*	0.02	0.09	1	
7. Mental health score 2012	0.14	-0.54*	0.78*	-0.41*	0.37*	0.34*	1

*P<0.05.

**Table 4: Direct, Indirect and Total effect of Variables on Mental Health Score in 2005 (n=2584) and 2012 (n=335)**

Variables	Direct Effect	Indirect Effect	Total Effect
Baseline (2005)			
Physical activity	-0.34	-	-0.344
Phone call with Friends (hours/day)	-0.47	-0.041	-0.511
Internet use (hours/day)	0.41	-0.015	0.395
TV watching (hours/day)	0.27	-0.015	0.255
Fallow up (2012)			
Physical activity	-0.39	-	-0.387
Phone call with Friends (hours/day)	-0.24	-0.050	-0.294
Internet use (hours/day)	0.14	-0.011	0.129
TV watching (hours/day)	0.17	-0.011	0.159
Mental health score 2005	0.42	-	0.420

At the baseline, the path analysis results showed that communicating with friends by phone and physical activity were the strongest associations with better mental health, respectively, while internet use and TV-watching distorted adolescents' mental health (Table 4, Figure 1).

At the baseline, female gender showed a significant association with physical activity, internet use, TV-watching and communicating with friends by phone, thus sex variable was entered to path model as a confounding variable.

The model indicated a good fit with the data. The explanatory power of the path analysis model for mental health was 29% and it was 36% in the follow-up in 2005.
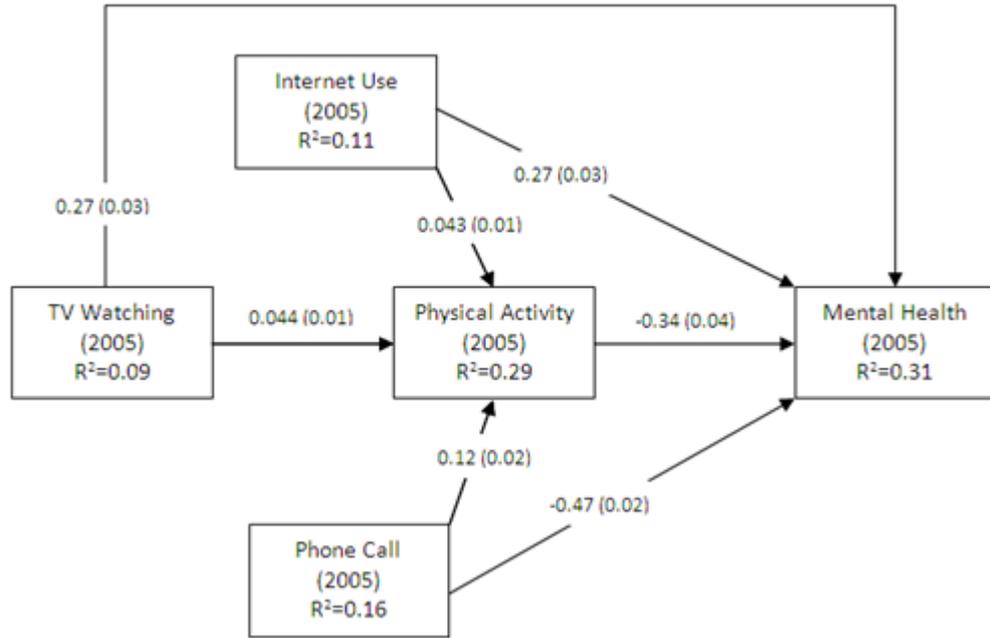
χ ^{2}(6) = 5.17, p= 0.78, RMSEA= 0.017, GFI=0.88, AGFI=0.90
Figure 1: The path analysis model of mental health for the participants over a seven-year follow-up period in 2005 The numbers show the maximum likelihood estimates of the path coefficients, standard errors are given in parentheses. R^2=squared multiple correlations. (Indirect effects in broken line)
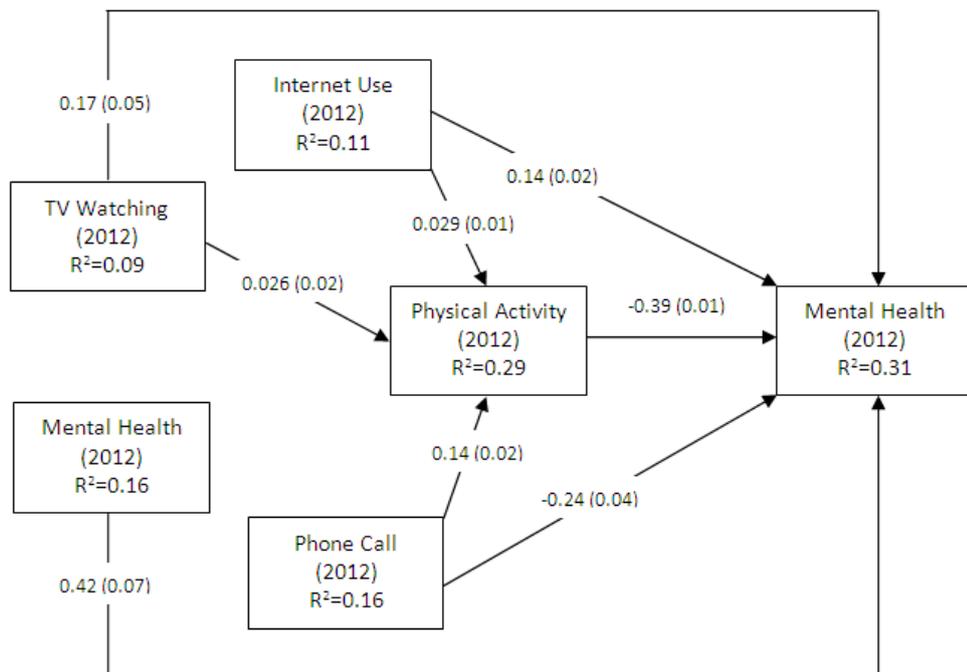
χ 2(7) = 5.74, p= 0.68, RMSEA= 0.023, GFI=0.94, AGFI=0.91
Figure 2: The path analysis model of mental health in 2012 for the participants over a seven-year follow-up period The numbers show the maximum likelihood estimates of the path coefficients, standard errors are given in parentheses. R2=squared multiple correlations. (Indirect effects in broken line)

Discussion

To our knowledge, this study was the first population based study on mental health problems conducted on adolescents of Bushehr province using the GHQ-28 questionnaire. This prospective seven year observational study was mainly concerned with the roles and impacts of physical activity, using the internet, television watching, phone conversation with friends and gender on mental health among high school students at baseline and follow up. The predictors of mental health problems were investigated using the path analysis model. The path analysis is superior to ordinary regression analysis because it allows us to move beyond the estimation of direct effects, the basic output of regression. Rather, the path analysis allows one to examine the causal processes underlying the observed relationships and to estimate the relative importance of the paths of influence. Similar to previous studies14, 16, the results in 2005 and 2012 showed that phone call and physical activity had the strongest associations with better mental disorders symptoms, while internet use and TV-watching were distorted mental health of adolescents (Table4).

After communicating with friends by phone, the most important predictor of mental health at baseline was internet use, while at the follow up it was mental health at baseline and physical activity. Our results revealed a protective effect of phone conversation with friends and physical activity on mental health at baseline and follow-up, whereas internet use and TV-watching distorted mental health in follow-up. Similar to our study, Sagatun et al. found a significant association between physical activity and mental health among 15-16 year-old students (24). An important finding of our study was the significant negative association between mental health problems and phone conversation with friends in 2005 ($r = -0.47$, $p<0.05$; Figure 1). Thus, phone conversation was the factor inhibitor of mental health problems. This finding was not observed in previous investigations of adolescents' mental health (7, 10-16). Another important finding was the positive association between internet use and mental health problems at baseline and follow-up ($p<0.05$, Tables 2-4). This result was concordant with previous studies (25).In addition, similar to some studies (26) using the internet increased mental health problems at baseline and follow-up (25). This is in agreement with earlier studies which have shown that mental health is associated with internet addiction (26-28). TV-watching and internet use which were mental health inhibitors in this study were increased at follow-up compared to baseline (Table 1). Therefore, the results of this study should be taken as a warning sign by the authorities in south of Iran. Previous study showed that psychological problems in Fars province adolescents, in south of Iran were higher than expected (29). Our results showed that at the baseline, phone conversation with friends were stronger predictors of mental health than the other predictors, but at the follow-up baseline mental health were stronger predictors of mental health

than the other predictors. Therefore, the predictors of mental health will change over time. The dimensions of mental health such as depression, anxiety and somatic distress remained significantly unchanged during the 7-year follow up (Table 1). Nonetheless, the proportion of social dysfunction problem was significantly decreased among both groups during the 7- year follow-up. The final model (Figure 2) supports our hypothetical model of mental health. The explanatory power of the path analysis model at the baseline (29%) and follow up (36%) was fairly low. However, the model worked well and indicated a statistically good fit to data .

Because of the multi-factorial nature of mental health, the associations observed between mental health and the predictors in the present study should be interpreted with caution. The main strength of this study is its fairly large random sample of adolescents and its reasonably high rates of participation. The use of a prospective study allowed us to examine both the cross-sectional and the causal relationships between mental health and the predictors.

This study had some limitations. First, this study mainly relied on the accuracy of self-reports at both baseline and follow up. Second, participants in the follow up were not selected randomly and we selected 30% of the students in 2005 based on budget and facilities as convenience samples in 2012. Third, we did not have enough time and budget for the follow-up of the participants. Forth, it was very difficult to find the students, and they were not much interested to participate in the study. Finally, the study was conducted in Bushehr province and these results are not generalizable to the whole Iran.

Conclusion

This study indicated that the prevalence of mental health problems is serious among high school students in Bushehr province in 2005 and it did not decrease in later years (2012). The findings of this study indicated that male gender, better mental health at baseline, higher physical activity and phone communication with friends, less use of internet and TV are associated with and may predict mental health in later years.

Acknowledgments

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