Test-Retest Reliability of a Questionnaire for the Korea Youth Risk Behavior Web-Based Survey

Jisuk Bae[1], Hyojee Joung[2], Jong-Yeon Kim[1], Kyoung Nam Kwon[3], Young Taek Kim[4], Soon-Woo Park[1]

[1]Department of Preventive Medicine, Catholic University of Daegu School of Medicine; [2]Seoul National University School of Public Health; [3]Lotte Samkang Co., Ltd.; [4]Korea Centers for Disease Control and Prevention

Objectives: A web-based survey has been administered annually since 2005 throughout Korea to assess the prevalence of adolescent health risk behaviors among middle and high school students. The aim of this study was to evaluate the test-retest reliability of the Korea Youth Risk Behavior Web-based Survey (KYRBWS) questionnaire.
Methods: A convenience sample of 2298 middle and high school students participated in self-administered questionnaire surveys twice, approximately two weeks apart, in 2008. The percent agreement, kappa statistics, and prevalence rates at the first and second surveys were computed for the core subset of 39 self-reported health risk behavior indices of the KYRBWS.
Results: Among 39 indices, seven indices had kappas $\geq$ 0.81 and all of the indices had kappas $\geq$ 0.41. Based on non-overlapping 95% confidence intervals, three indices had significantly different prevalence rates between the first and second surveys. In the subgroup analyses by school grade and gender, two indices had significantly different reliability estimates between middle and high school students. There were no significantly different reliability estimates between male and female students, except for one index.
Conclusions: This study demonstrated that the reliability estimates for the KYRBWS questionnaire are varied, but generally reliable over time. The indices with low reliability estimates need to be evaluated further in order to determine whether the indices should be modified or deleted from future versions of the KYRBWS.

Key words: Adolescent, Health surveys, Questionnaires, Reproducibility of results
J Prev Med Public Health 2010;43(5):403-410

INTRODUCTION

In the Republic of Korea in 2007, cancer and cardiovascular disease were the leading causes of death [1]. Health risk behaviors, such as tobacco use and physical inactivity, are known to be major contributors to the development and progress of these chronic diseases [2]. Because personal lifestyle in youth is highly correlated with that in later life, establishing a healthy lifestyle in youth is essential for reducing the social and economic burden of chronic diseases [3].

The Korea Youth Risk Behavior Web-base Survey (KYRBWS) has been administered annually since 2005 to assess the nationwide prevalence of adolescent health risk behaviors among middle and high school students [4-6]. In the 2007 KYRBWS questionnaire, the categories of the survey included the following: 1) tobacco use; 2) alcohol use; 3) obesity and weight control; 4) physical activity; 5) dietary behaviors; 6) unintentional injury behaviors; 7) substance use; 8) sexual behaviors; 9) mental health-related behaviors; 10) oral health-related behaviors; 11) hand hygiene; 12) allergic diseases; and

13) health equity [6]. With its strength of the web-based surveillance system, the KYRBWS has yielded adolescent self-reports across diverse health risk behavior categories.

National surveillance systems for monitoring adolescent health risk behaviors have been implemented in many countries, particularly in Europe and North America. Specially, the Health Behavior in School-aged Children (HBSC) Study is a World Health Organization collaborative cross-national study which includes 43 participating countries in Europe and North America [7]. The Youth Risk Behavior Surveillance System (YRBSS) in the United States includes a national school-based survey conducted by the Centers for Disease Control and Prevention (CDC), and state and local school-based surveys conducted by state and local education and health agencies [8].

As the findings from these surveys are used to implement school health policies and practices at national, regional, and international levels, it is essential to ensure the accuracy of adolescent self-reports across diverse health risk behavior categories. For this purpose,

several studies have been conducted to assess the test-retest reliability of these survey questionnaires [9-13]. However, it has not been evaluated whether or not a wide range of self-reported health risk behaviors among Korean adolescents are reliable over time. Thus, the current study presents the first evaluation of the test-retest reliability of the KYRBWS questionnaire.

METHODS

I. Subjects

A convenience sample of students was selected from five middle schools and 14 high schools in four geographically-defined areas, which included both rural (Gyeonggi-do and Gyeongsangbuk-do) and urban (Daegu Metropolitan City and Seoul Metropolitan Government) areas. In each selected school, one (boys' or girls' schools) or two (co-educational schools) classes at each grade level were selected in a convenient basis.

Parental informed consent forms were distributed one week in advance of the administration of the first survey. Only parents who did not want their children to participate in the study were required to sign and return the form (negative consent). A total of 2453 students in the selected classes were eligible to participate. After excluding students who declined participation, 2356 students (96.0%) completed the first survey. Among the 2356 students, 2298 students (97.5%) completed the second survey.

II. Data Collection

Data collection began in May 2008 and ended in June 2008. Well-trained data collectors explained the objective of the survey and the entire survey process to the students before the administration of the first survey. The survey, which took 45 to 50 minutes, was administered twice, approximately two weeks apart, in a computer room of each selected school. The students were required to visit the KYRBWS website and logged in with a unique number, which was assigned to each student to assure anonymity. After logging in, the students completed the self-administered questionnaire (Time 1). After the administration of the first survey, each student was required to put his or her unique number card into an envelope. The envelope was sealed by the student, and the student wrote their number across the seal. The sealed envelope was held by the data collectors and redistributed to the students during the

Table 1. Demographic characteristics of the sample of 2,298 students and of middle and high school students nationwide

Characteristic	Sample distribution		National distribution*	
	n	%	n	%
Gender				
Male	1144	49.8	2093355	53.1
Female	1154	50.2	1852234	46.9
School grade				
Middle school 1st	280	12.2	679350	17.2
Middle school 2nd	254	11.1	677485	17.2
Middle school 3rd	274	11.9	681776	17.3
High school 1st	532	23.2	683181	17.3
High school 2nd	504	21.9	646630	16.4
High school 3rd	454	19.8	577167	14.6
Area				
Gyeonggi-do	624	27.2	924838	44.7
Gyeongsangbuk-do	521	22.7	196989	9.5
Daegu Metropolitan City	577	25.1	220335	10.7
Seoul Metropolitan Government	576	25.1	727521	35.2

* Source: Korean Educational Development Institute, 2008 [15].

administration of the second survey. The students were required to open their envelopes and log in with the same unique number during the administration of the second survey (Time 2). The students' responses at Time 1 and Time 2 were automatically stored in the database of the KYRBWS and matched by the unique number.

The 2007 KYRBWS questionnaire, which was used in the first and second surveys, consisted of 129 questions [6]. Some questions in the questionnaire were automatically skipped according to the students' responses during the administration of the web-based survey. The Korea CDC developed 113 indices to assess adolescent health risk behaviors from the students' responses to the 129 questions of the questionnaire [6]. The core subset of these indices was used for assessment of the test-retest reliability of the KYRBWS questionnaire. The selected indices were computed from the questions which had the following reference periods: past 30 days, past 12 months, lifetime, and other (next six months or not specified). The questions which involved the reference periods of yesterday or the past seven days were excluded in the current study. A total of 39 indices were evaluated in this study, which included some comparable indices to other nations' survey data [9-11].

III. Statistical Analyses

A total of 2298 students who completed both the first and second surveys were used for the assessment of test-retest reliability. The percent agreement and kappa statistics were calculated for the selected 39 indices of the KYRBWS. The prevalence rates based on the first

Table 2. Percent agreement, kappa statistics, and prevalence rates for respondents from four selected areas* in Korea, 2008

Index	n	% Agree-ment	Kappa (95% CI)	Prevalence (%) Time 1	Time2[+]
Tobacco use behaviors					
Ever used cigarettes (ever smokers)	2298	93.4	0.84 (0.82 - 0.87)	30.0	28.2
Age at which cigarette smoking was first tried even one or two puffs < 13 years (among ever smokers)	594	92.8	0.82 (0.77 - 0.87)	29.8	28.3
Smoked ≥ 20 days during the past 30 days (among ever smokers)	594	93.3	0.84 (0.79 - 0.89)	29.1	28.8
Smoked cigarettes daily during the past 30 days (among ever smokers)	594	94.6	0.85 (0.80 - 0.90)	24.6	23.9
Smoked ≥ 1 day during the past 30 days (among ever smokers, current smokers)	594	87.0	0.74 (0.69 - 0.79)	50.3	45.1
Smoked ≥ 10 cigarettes per day on the days smoked during the past 30 days (among current smokers)	245	90.2	0.72 (0.61 - 0.82)	23.3	21.6
Had an intention to quit cigarette smoking within the next 6 months (among current smokers)	245	77.6	0.55 (0.45 - 0.66)	49.8	51.0
Bought cigarettes in a store during the past 30 days (among current smokers)	245	86.9	0.68 (0.57 - 0.78)	71.4	72.2
Alcohol and other drug use behaviors					
Ever used alcohol (ever drinkers)	2298	88.3	0.76 (0.73 - 0.79)	59.1	56.7
Age at which alcohol was first consumed < 13 years (among ever drinkers)	1195	91.2	0.75 (0.70 - 0.79)	22.2	22.8
Drank at least one drink of alcohol during the past 30 days (among ever drinkers, current drinkers)	1195	78.9	0.58 (0.53 - 0.62)	48.5	41.8[+]
Had episodic heavy drinking during the past 30 days (among current drinkers)	414	80.4	0.56 (0.47 - 0.64)	35.3	30.7
Bought alcohol in a store during the past 30 days (among current drinkers)	414	87.0	0.73 (0.66 - 0.80)	61.1	58.2
Ever used inhalants	2298	98.3	0.45 (0.31 - 0.59)	1.4	1.8
Ever used stimulants	2298	98.1	0.62 (0.52 - 0.73)	2.4	2.7
Ever used hypnotics	2298	98.7	0.55 (0.41 - 0.70)	1.5	1.4
Unintentional and intentional injury behaviors					
Always or usually wears a seatbelt when riding in a car (among ever riders)	2161	80.8	0.62 (0.58 - 0.65)	49.1	50.4
Always or usually wears a helmet when riding a motorcycle (among ever riders)	490	81.2	0.50 (0.41 - 0.58)	24.3	25.1
Always or usually wears a helmet when riding a bicycle (among ever riders)	1601	97.6	0.45 (0.30 - 0.59)	1.8	2.6
Seriously considered attempting suicide during the past 12 months	2298	87.3	0.58 (0.53 - 0.62)	20.4	16.5[+]
Had ≥ 1 suicide attempt during the past 12 months (among respondents who seriously considered attempting suicide)	278	88.1	0.70 (0.60 - 0.79)	26.6	27.0
Weight control behaviors					
Perceive self as overweight or obese	2289	93.8	0.85 (0.83 - 0.88)	29.2	28.4
Tried to lose weight during the past 12 months	2298	84.9	0.67 (0.64 - 0.70)	36.1	35.2
Ever taken diet pills to lose weight or keep from gaining weight	2298	98.1	0.72 (0.64 - 0.80)	3.7	3.4
Sexual behaviors					
Ever had sexual intercourse	2298	97.7	0.76 (0.70 - 0.83)	5.0	5.1
Age at the time of first sexual intercourse < 13 years (among respondents who ever had sexual intercourse)	90	97.8	0.79 (0.51 - 1.00)	6.7	4.4
Ever had sexually transmitted diseases (among respondents who ever had sexual intercourse)	90	95.6	0.64 (0.32 - 0.97)	6.7	6.7
Ever been pregnant (among female students who ever had sexual intercourse)	39	97.4	0.84 (0.54 - 1.00)	7.7	10.3
Ever experienced artificial abortion (among female students who ever been pregnant)	3	100.0	1.00 (1.00 - 1.00)	66.7	66.7
Oral health-related behaviors					
Went to the dentist during the past 12 months	2298	83.1	0.66 (0.63 - 0.69)	57.9	49.0[+]
Applied dental sealants to prevent dental caries during the past 12 months (among respondents who went to the dentist)	1034	81.5	0.60 (0.55 - 0.65)	38.6	35.4
Applied topical fluorides to prevent dental caries during the past 12 months (among respondents who went to the dentist)	1034	94.4	0.68 (0.60 - 0.75)	10.2	9.0
Received dental scaling during the past 12 months (among respondents who went to the dentist)	1034	88.9	0.71 (0.66 - 0.76)	26.9	25.0
Hand hygiene					
Always or usually washed hands before eating during the past 30 days	2298	80.6	0.55 (0.51 - 0.59)	66.7	70.2
Always or usually washed hands after using toilet during the past 30 days	2298	90.4	0.54 (0.49 - 0.60)	87.3	88.9
Always or usually used soap when washing hands during the past 30 days	2298	83.5	0.61 (0.58 - 0.65)	70.4	68.8
Allergic diseases					
Ever been diagnosed with asthma by a physician	2298	96.1	0.74 (0.69 - 0.79)	8.0	8.1
Ever been diagnosed with allergic rhinitis by a physician	2298	93.3	0.80 (0.77 - 0.83)	20.8	20.6
Ever been diagnosed with atopic dermatitis by a physician	2298	93.5	0.75 (0.71 - 0.79)	15.8	15.3

CI: confidence interval.

* Areas included: Gyeonggi-do, Gyeongsangbuk-do, Daegu Metropolitan City, and Seoul Metropolitan Government.

[+] Non-overlapping confidence intervals.

and second surveys were also calculated for these indices. The qualitative values of the kappa statistics were determined based on the criteria described by Landis and Koch as follows: ≤ 0.00, poor; 0.00-0.20, slight; 0.21-0.40, fair; 0.41-0.60, moderate; 0.61-0.80, substantial; and 0.81-1.00, almost perfect [14]. Statistically significant differences between the estimates were assessed based on non-overlapping 95% confidence intervals. Statistical analyses were conducted using SAS version 9.1(SAS Inc., Cary, NC, USA). This study was approved by the Institutional Review Board of Daegu Catholic University Medical Center.

RESULTS

Among 2298 respondents, 49.8% were male students and 50.2% were female students. Middle school students comprised 35.2% and high school students comprised 64.9%. Compared to the national distribution by gender and school grade, the sample distribution had a higher proportion of female students and high school students. Regarding the distribution by area, students in Gyeongsangbuk-do and Daegu Metropolitan City were over-represented in the sample (Table 1)[15].

The reliability estimates for the selected 39 indices of the KYRBWS questionnaire are shown in Table 2. Among these indices, seven indices (17.9%) had kappas between 0.81 and 1.00 ("almost perfect" reliability). Twenty-one indices (53.8%) had kappas between 0.61 and 0.80 ("substantial" reliability). Eleven indices (28.2%) had kappas between 0.41 and 0.60 ("moderate" reliability). None of the indices had kappas between 0.40 and 0.00 or less ("fair," "slight," or "poor" reliability). The percent agreement ranged between 77.6% and 100.0% for all indices. Three indices (7.7%) had significantly different prevalence rates between the first and second surveys.

Table 3 shows the distribution of kappa statistics by health risk behavior categories and the reference periods of indices. Among eight indices in the category of tobacco use behaviors, four indices (50.0%) had kappas ≥ 0.81. Among three indices in the category of hand hygiene, two indices (66.7%) had kappas ≤ 0.60. Among 16 indices which used lifetime as a reference period, four indices (25.0%) had kappas ≥ 0.81, whereas two indices (12.5%) had kappas ≤ 0.60.

The assessment of reliability by gender revealed that there were no significantly different reliability estimates between male and female students, with the exception of

Table 3. Distribution* of kappa statistics by health risk behavior categories and the reference periods of indices

Characteristics	n	Kappa (%)		
		0.41-0.60	0.61-0.80	0.81-1.00
Health risk behavior categories				
Tobacco use behaviors	8	1 (12.5)	3 (37.5)	4 (50.0)
Alcohol and other drug use behaviors	8	4 (50.0)	4 (50.0)	0 (-)
Unintentional and intentional injury behaviors	5	3 (60.0)	2 (40.0)	0 (-)
Weight control behaviors	3	0 (-)	2 (66.7)	1 (33.3)
Sexual behaviors	5	0 (-)	3 (60.0)	2 (40.0)
Oral health-related behaviors	4	1 (25.0)	3 (75.0)	0 (-)
Hand hygiene	3	2 (66.7)	1 (33.3)	0 (-)
Allergic diseases	3	0 (-)	3 (100.0)	0 (-)
Reference periods				
Lifetime	16	2 (12.5)	10 (62.5)	4 (25.0)
Past 12 months	7	2 (28.6)	5 (71.4)	0 (-)
Past 30 days	11	4 (36.4)	5 (45.5)	2 (18.2)
Others[†]	5	3 (60.0)	1 (20.0)	1 (20.0)

*Data were expressed as n (%).
[†] Reference periods included: next six months (one index) and not specified (four indices).

one index. However, female students had somewhat higher reliability estimates than male students in general. Except for two indices computed among girls alone, four indices (10.8%) had kappas ≥ 0.81 among male students and eight indices (21.6%) had kappas ≥ 0.81 among female students (Table 4).

In the subgroup analyses by school grade, two indices had significantly different reliability estimates between middle and high school students. The results indicated that the responses of high school students were more consistent than those of middle school students in general. Except for three indices with non-estimated kappas, three indices (8.3%) had kappas ≥ 0.81 among middle school students and six indices (16.7%) had kappas ≥ 0.81 among high school students (Table 5).

DISCUSSION

This study demonstrated that self-reported health risk behaviors among Korean middle and high school students were reliable over time. In our study, several indices had relatively low kappa values (e.g. drug use behaviors), but values of the percent agreement were high, ranging from 77.6% to 100.0% for all indices (> 98.0% for indices involving drug use behaviors). With respect to indices with very low or very high prevalence rates, low values of kappa could be obtained. On the other hand, when the prevalence rates are significantly

Table 4. Kappa statistics and 95% confidence intervals (CIs) for respondents stratified by gender

Index	Male Kappa (95% CI)	Female Kappa (95% CI)*
Tobacco use behaviors		
Ever used cigarettes (ever smokers)	0.81 (0.78 - 0.85)	0.87 (0.84 - 0.91)
Age at which cigarette smoking was first tried even one or two puffs < 13 years (among ever smokers)	0.68 (0.60 - 0.77)	0.72 (0.60 - 0.84)
Smoked ≥ 20 days during the past 30 days (among ever smokers)	0.82 (0.75 - 0.88)	0.87 (0.79 - 0.95)
Smoked cigarettes daily during the past 30 days (among ever smokers)	0.83 (0.77 - 0.90)	0.89 (0.81 - 0.97)
Smoked ≥ 1 day during the past 30 days (among ever smokers, current smokers)	0.75 (0.68 - 0.82)	0.71 (0.62 - 0.80)
Smoked ≥ 10 cigarettes per day on the days smoked during the past 30 days (among current smokers)	0.70 (0.57 - 0.82)	0.78 (0.59 - 0.96)
Had an intention to quit cigarette smoking within the next 6 months (among current smokers)	0.54 (0.41 - 0.66)	0.58 (0.40 - 0.77)
Bought cigarettes in a store during the past 30 days (among current smokers)	0.68 (0.55 - 0.81)	0.66 (0.49 - 0.84)
Alcohol and other drug use behaviors		
Ever used alcohol (ever drinkers)	0.71 (0.67 - 0.75)	0.81 (0.77 - 0.84)*
Age at which alcohol was first consumed < 13 years (among ever drinkers)	0.71 (0.64 - 0.78)	0.78 (0.72 - 0.84)
Drank at least one drink of alcohol during the past 30 days (among ever drinkers, current drinkers)	0.57 (0.51 - 0.64)	0.58 (0.52 - 0.64)
Had episodic heavy drinking during the past 30 days (among current drinkers)	0.48 (0.35 - 0.61)	0.62 (0.52 - 0.73)
Bought alcohol in a store during the past 30 days (among current drinkers)	0.78 (0.69 - 0.87)	0.69 (0.59 - 0.78)
Ever used inhalants	0.41 (0.25 - 0.58)	0.55 (0.27 - 0.83)
Ever used stimulants	0.51 (0.33 - 0.69)	0.69 (0.57 - 0.82)
Ever used hypnotics	0.49 (0.29 - 0.69)	0.62 (0.42 - 0.82)
Unintentional and intentional injury behaviors		
Always or usually wears a seatbelt when riding in a car (among ever riders)	0.58 (0.53 - 0.63)	0.64 (0.60 - 0.69)
Always or usually wears a helmet when riding a motorcycle (among ever riders)	0.46 (0.34 - 0.58)	0.54 (0.40 - 0.67)
Always or usually wears a helmet when riding a bicycle (among ever riders)	0.41 (0.22 - 0.59)	0.51 (0.28 - 0.74)
Seriously considered attempting suicide during the past 12 months	0.51 (0.44 - 0.58)	0.62 (0.57 - 0.68)
Had ≥ 1 suicide attempt during the past 12 months (among respondents who seriously considered attempting suicide)	0.54 (0.33 - 0.74)	0.76 (0.66 - 0.87)
Weight control behaviors		
Perceive self as overweight or obese	0.87 (0.84 - 0.91)	0.83 (0.80 - 0.87)
Tried to lose weight during the past 12 months	0.63 (0.58 - 0.69)	0.67 (0.62 - 0.71)
Ever taken diet pills to lose weight or keep from gaining weight	0.66 (0.49 - 0.83)	0.73 (0.64 - 0.82)
Sexual behaviors		
Ever had sexual intercourse	0.72 (0.64 - 0.81)	0.82 (0.74 - 0.91)
Age at the time of first sexual intercourse < 13 years (among respondents who ever had sexual intercourse)	0.65 (0.20 - 1.00)	1.00 (1.00 - 1.00)
Ever had sexually transmitted diseases (among respondents who ever had sexual intercourse)	0.54 (0.08 - 1.00)	0.79 (0.38 - 1.00)
Ever been pregnant (among female students who ever had sexual intercourse)	N/E	0.84 (0.54 - 1.00)
Ever experienced artificial abortion (among female students who ever been pregnant)	N/E	1.00 (1.00 - 1.00)
Oral health-related behaviors		
Went to the dentist during the past 12 months	0.63 (0.58 - 0.67)	0.69 (0.65 - 0.73)
Applied dental sealants to prevent dental caries during the past 12 months (among respondents who went to the dentist)	0.52 (0.44 - 0.61)	0.66 (0.60 - 0.72)
Applied topical fluorides to prevent dental caries during the past 12 months (among respondents who went to the dentist)	0.59 (0.48 - 0.71)	0.76 (0.66 - 0.86)
Received dental scaling during the past 12 months (among respondents who went to the dentist)	0.67 (0.60 - 0.75)	0.74 (0.68 - 0.81)
Hand hygiene		
Always or usually washed hands before eating during the past 30 days	0.48 (0.42 - 0.54)	0.59 (0.54 - 0.64)
Always or usually washed hands after using toilet during the past 30 days	0.48 (0.40 - 0.56)	0.60 (0.53 - 0.66)
Always or usually used soap when washing hands during the past 30 days	0.58 (0.53 - 0.63)	0.64 (0.59 - 0.69)
Allergic diseases		
Ever been diagnosed with asthma by a physician	0.71 (0.64 - 0.78)	0.77 (0.70 - 0.85)
Ever been diagnosed with allergic rhinitis by a physician	0.76 (0.71 - 0.80)	0.84 (0.80 - 0.88)
Ever been diagnosed with atopic dermatitis by a physician	0.73 (0.68 - 0.79)	0.77 (0.72 - 0.82)

N/E: not estimated.
* Non-overlapping confidence intervals.

different between Time 1 and Time 2, high values of kappa could be obtained. Because of these characteristics of kappa, the estimates should be interpreted with caution in conjunction with other measures of reliability, such as percent agreement [16-18].

One of the important findings in this study was that the reliability estimates among middle school students tended to be lower than those among high school students. The differences in prevalence rates of health

Table 5. Kappa statistics and 95% confidence intervals (CIs) for respondents stratified by school grade

Index	Middle school Kappa (95% CI)	High school Kappa (95% CI)*
Tobacco use behaviors		
Ever used cigarettes (ever smokers)	0.78 (0.73 - 0.84)	0.86 (0.83 - 0.89)
Age at which cigarette smoking was first tried even one or two puffs < 13 years (among ever smokers)	0.58 (0.35 - 0.80)	0.71 (0.63 - 0.78)
Smoked ≥ 20 days during the past 30 days (among ever smokers)	0.60 (0.37 - 0.84)	0.85 (0.80 - 0.90)
Smoked cigarettes daily during the past 30 days (among ever smokers)	0.60 (0.31 - 0.89)	0.86 (0.81 - 0.91)
Smoked ≥ 1 day during the past 30 days (among ever smokers, current smokers)	0.52 (0.38 - 0.66)	0.80 (0.75 - 0.86)*
Smoked ≥ 10 cigarettes per day on the days smoked during the past 30 days (among current smokers)	1.00 (1.00 - 1.00)	0.69 (0.57 - 0.80)*
Had an intention to quit cigarette smoking within the next 6 months (among current smokers)	0.42 (0.10 - 0.74)	0.55 (0.45 - 0.66)
Bought cigarettes in a store during the past 30 days (among current smokers)	0.57 (0.31 - 0.84)	0.65 (0.53 - 0.78)
Alcohol and other drug use behaviors		
Ever used alcohol (ever drinkers)	0.70 (0.65 - 0.75)	0.76 (0.72 - 0.79)
Age at which alcohol was first consumed < 13 years (among ever drinkers)	0.73 (0.64 - 0.81)	0.70 (0.63 - 0.76)
Drank at least one drink of alcohol during the past 30 days (among ever drinkers, current drinkers)	0.47 (0.36 - 0.58)	0.60 (0.55 - 0.65)
Had episodic heavy drinking during the past 30 days (among current drinkers)	0.53 (0.29 - 0.76)	0.56 (0.47 - 0.65)
Bought alcohol in a store during the past 30 days (among current drinkers)	0.77 (0.62 - 0.93)	0.71 (0.63 - 0.78)
Ever used inhalants	0.49 (0.30 - 0.67)	0.39 (0.17 - 0.62)
Ever used stimulants	0.62 (0.43 - 0.81)	0.62 (0.50 - 0.75)
Ever used hypnotics	0.28 (-0.03 - 0.59)	0.62 (0.47 - 0.78)
Unintentional and intentional injury behaviors		
Always or usually wears a seatbelt when riding in a car (among ever riders)	0.60 (0.54 - 0.65)	0.63 (0.59 - 0.67)
Always or usually wears a helmet when riding a motorcycle (among ever riders)	0.58 (0.44 - 0.71)	0.44 (0.32 - 0.56)
Always or usually wears a helmet when riding a bicycle (among ever riders)	0.52 (0.34 - 0.70)	0.31 (0.07 - 0.55)
Seriously considered attempting suicide during the past 12 months	0.59 (0.52 - 0.66)	0.57 (0.51 - 0.62)
Had ≥ 1 suicide attempt during the past 12 months (among respondents who seriously considered attempting suicide)	0.68 (0.52 - 0.83)	0.71 (0.59 - 0.84)
Weight control behaviors		
Perceive self as overweight or obese	0.84 (0.80 - 0.88)	0.86 (0.83 - 0.89)
Tried to lose weight during the past 12 months	0.64 (0.58 - 0.70)	0.69 (0.65 - 0.73)
Ever taken diet pills to lose weight or keep from gaining weight	0.67 (0.51 - 0.84)	0.73 (0.64 - 0.82)
Sexual behaviors		
Ever had sexual intercourse	0.39 (0.15 - 0.64)	0.81 (0.75 - 0.87)
Age at the time of first sexual intercourse < 13 years (among respondents who ever had sexual intercourse)	1.00 (1.00 - 1.00)	0.66 (0.21 - 1.00)
Ever had sexually transmitted diseases (among respondents who ever had sexual intercourse)	N/E	0.64 (0.32 - 0.97)
Ever been pregnant (among female students who ever had sexual intercourse)	N/E	0.84 (0.54 - 1.00)
Ever experienced artificial abortion (among female students who ever been pregnant)	N/E	1.00 (1.00 - 1.00)
Oral health-related behaviors		
Went to the dentist during the past 12 months	0.62 (0.57 - 0.68)	0.68 (0.64 - 0.72)
Applied dental sealants to prevent dental caries during the past 12 months (among respondents who went to the dentist)	0.55 (0.47 - 0.63)	0.64 (0.58 - 0.70)
Applied topical fluorides to prevent dental caries during the past 12 months (among respondents who went to the dentist)	0.67 (0.57 - 0.78)	0.67 (0.55 - 0.79)
Received dental scaling during the past 12 months (among respondents who went to the dentist)	0.63 (0.54 - 0.72)	0.76 (0.70 - 0.81)
Hand hygiene		
Always or usually washed hands before eating during the past 30 days	0.45 (0.37 - 0.53)	0.57 (0.53 - 0.61)
Always or usually washed hands after using toilet during the past 30days	0.49 (0.39 - 0.59)	0.57 (0.50 - 0.63)
Always or usually used soap when washing hands during the past 30 days	0.64 (0.58 - 0.70)	0.59 (0.55 - 0.64)
Allergic diseases		
Ever been diagnosed with asthma by a physician	0.78 (0.71 - 0.86)	0.71 (0.64 - 0.78)
Ever been diagnosed with allergic rhinitis by a physician	0.75 (0.70 - 0.81)	0.82 (0.78 - 0.85)
Ever been diagnosed with atopic dermatitis by a physician	0.75 (0.69 - 0.82)	0.75 (0.70 - 0.80)

N/E: not estimated.
* Non-overlapping confidence intervals.

risk behaviors between middle and high school students may have affected the reliability estimates. Nevertheless, the reduced reliability among middle school students may be attributable to a lower ability to comprehend the words and sentences in the questionnaire than that among high school students. The KYRBWS questionnaire was intended for use among both middle and high school students. Therefore, this study suggests that indices requiring a high level of comprehension skills should be modified in order to reduce measurement

errors and improve the accuracy of the survey data.

The test-retest reliability estimates of the KYRBWS questionnaire are, in part, comparable with those of the United States YRBSS questionnaire. First, the reliability estimates tended to be different across health risk behavior categories [10,11]. As shown in our study, the health risk behaviors which are more salient to adolescents, such as tobacco use behaviors, might have had higher reliability estimates. On the other hand, the health risk behaviors which are more time- and situation-dependent, such as behaviors related to hand hygiene, might have had lower reliability estimates. Second, the indices which used lifetime as a reference period tended to have higher reliability estimates than the indices which used any other reference periods among both Korean and American adolescents. This is not surprising, given that remembering events during the specific time intervals requires more complex cognitive demands than remembering events experienced over a lifetime. Third, the assessment of reliability by gender revealed that female students tended to have higher reliability estimates than male students in both the Republic of Korea and the United States. Although the underlying causes are not clear, the gender difference in the test-retest reliability might have been partly explained by the differences in prevalence rates of health risk behaviors or in the perception of certain behavioral events between male and female students [9-11].

In the assessment of test-retest reliability, inconsistent responses between Time 1 and Time 2 may be interpreted as response errors. However, these inconsistencies may reflect the possibility of real changes in health risk behaviors between Time 1 and Time 2. By labeling any change between Time 1 and Time 2 as a response error, our results provided conservative estimates of the test-retest reliability.

In order to ensure the accuracy of the survey data, not only the reliability, but also the validity of the data should be taken into account. In addition, factors affecting the reliability and validity of self-reported health risk behaviors need to be considered for the accurate interpretation and application of the survey data. Factors which may affect the reliability and validity of the survey data include the context of questions and the type of response required from the cognitive perspective [19].

The mode of survey administration may influence the reliability and validity of self-reported health risk behaviors as well. According to the mode of survey administration, the level of confidentiality and anonymity may be differently perceived among respondents. The perceived lack of confidentiality and anonymity may cause response errors, especially in questions on socially undesirable health risk behaviors. In several methodological studies, data from a self-administered questionnaire (SAQ) had higher reported rates of certain health risk behaviors, such as tobacco, alcohol, and other drug use, than those from an interviewer-administered questionnaire [20]. Similarly, data from computer-assisted self-interviewing had higher reported rates of certain health risk behaviors, such as sexual behaviors and violence-related behaviors, than those from paper-and-pencil SAQs [21]. Surveys administered in schools also tended to produce higher reported rates of health risk behaviors than those in households [22]. From this point of view, as a school-based survey administered via computer-assisted self-interviewing, the KYRBWS may be a source of accurate data on health risk behaviors among Korean adolescents. However, each mode of survey administration has advantages and disadvantages. For instance, SAQ may lead to a misunderstanding of questions, whereas interviewer-administered surveys allow for the clarification of any ambiguities.

One of the limitations of this study was that not all but the core subset of health risk behavior indices in the KYRBWS questionnaire was evaluated. With regard to indices in the category of physical activity and dietary behaviors, all indices were excluded from the analyses because the indices had the reference periods of yesterday or the past seven days. Moreover, the assessment of the test-retest reliability of the KYRBWS questionnaire was based on a convenience sample, not a nationally representative sample.

Data from national surveys aimed at monitoring adolescent health risk behaviors are used to implement school health policies and practices at regional, national, and international levels. School health policy-makers and practitioners who use these data should give attention to the reliability and validity of self-reported health risk behaviors for the accurate interpretation and application of the data. The findings from our study could be used to identify the indices with low reliability estimates of the KYRBWS questionnaire. Our study demonstrated that the reliability estimates for the KYRBWS questionnaire are varied, but generally reliable over time. The indices with low reliability estimates need to be evaluated further in order to determine whether the indices should be modified or deleted from future versions of the KYRBWS.

ACKNOWLEDGEMENTS

CONFLICT OF INTEREST

The authors have no conflict of interest to declare on this study.

REFERENCES

1. Korea National Statistical Office. *Annual Report on the Cause of Death Statistics, 2007*. Daejeon: Korea National Statistical Office; 2008. (Korean)

2. Mokdad AH, Marks JS, Stroup DF, Gerberding JL. Actual causes of death in the United States, 2000. *JAMA* 2004; 291(10): 1238-1245.

3. McGue M, Iacono WG, Krueger R. The association of early adolescent problem behavior and adult psychopathology: a multivariate behavioral genetic perspective. *Behav Genet* 2006; 36(4): 591-602.

4. Korea Centers for Disease Control and Prevention. *Reports on the Korea Youth Risk Behavior Web-based Survey, 2005*. Seoul: Korea Centers for Disease Control and Prevention; 2007. (Korean)

5. Korea Centers for Disease Control and Prevention. *Reports on the Korea Youth Risk Behavior Web-based Survey, 2006*. Seoul: Korea Centers for Disease Control and Prevention; 2007. (Korean)

6. Korea Centers for Disease Control and Prevention. *Reports on the Korea Youth Risk Behavior Web-based Survey, 2007*. Seoul: Korea Centers for Disease Control and Prevention; 2008. (Korean)

7. Health Behaviour in School-aged Children. Health behaviour in school-aged children: a World Health Organization collaborative cross-national study. [cited 2010 May 31]. Available from: URL:http://www.hbsc.org.

8. Eaton DK, Kann L, Kinchen S, Shanklin S, Ross J, Hawkins J, et al. Youth risk behavior surveillance--United States, 2007. *MMWR Surveill Summ* 2008; 57(4): 1-131.

9. Brener ND, Collins JL, Kann L, Warren CW, Williams BI. Reliability of the Youth Risk Behavior Survey Questionnaire. *Am J Epidemiol* 1995; 141(6): 575-580.

10. Brener ND, Kann L, McManus T, Kinchen SA, Sundberg EC, Ross JG. Reliability of the 1999 youth risk behavior survey questionnaire. *J Adolesc Health* 2002; 31(4): 336-342.

11. Zullig KJ, Pun S, Patton JM, Ubbes VA. Reliability of the 2005 middle school Youth Risk Behavior Survey. *J Adolesc Health* 2006; 39(6): 856-860.

12. Vereecken CA, Maes L. A Belgian study on the reliability and relative validity of the Health Behaviour in School-Aged Children food-frequency questionnaire. *Public Health Nutr* 2003; 6(6): 581-588.

13. Booth ML, Okely AD, Chey T, Bauman A. The reliability and validity of the physical activity questions in the WHO health behaviour in schoolchildren (HBSC) survey: a population study. *Br J Sports Med* 2001; 35(4): 263-267.

14. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977; 33(1): 159-174.

15. Korean Educational Development Institute. *Statistical Yearbook of Education, 2008*. Seoul: Korean Educational Development Institute; 2008. (Korean)

16. Feinstein AR, Cicchetti DV. High agreement but low kappa: I. The problems of two paradoxes. *J Clin Epidemiol* 1990; 43(6): 543-549.

17. Cicchetti DV, Feinstein AR. High agreement but low kappa: II. Resolving the paradoxes. *J Clin Epidemiol* 1990; 43(6): 551-558.

18. Byrt T, Bishop J, Carlin JB. Bias, prevalence and kappa. *J Clin Epidemiol* 1993; 46(5): 423-429.

19. Brener ND, Billy JO, Grady WR. Assessment of factors affecting the validity of self-reported health-risk behavior among adolescents: evidence from the scientific literature. *J Adolesc Health* 2003; 33(6): 436-457.

20. Turner CF, Lessler JT, Devore JW. Effect of mode of administration and wording and reporting of drug use. In: Turner CF, Lessler JT, Gfroerer JC, editors. *Survey Measurement of Drug Use: Methodological Studies*. Washington, DC: Government Printing Office; 1992. p. 177-220.

21. Turner CF, Ku L, Rogers SM, Lindberg LD, Pleck JH, Sonenstein FL. Adolescent sexual behavior, drug use, and violence: Increased reporting with computer survey technology. *Science* 1998; 280(5365): 867-873.

22. Kann L, Brener ND, Warren CW, Collins JL, Giovino GA. An assessment of the effect of data collection setting on the prevalence of health-risk behaviors among adolescents. *J Adolesc Health* 2002; 31(4): 327-335.