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Association of problem behavior with sleep problem and gastroesophageal reflux symptom

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Running title: Problem behaviors, sleep problems, & GERD

Abstract

Background: There are few large-scale epidemiologic studies examining the associations between sleep problems, gastroesophageal reflux disease (GERD) symptoms, lifestyle and food habits and problem behaviors in adolescents. The objective of this study was to evaluate the associations among these factors in Japanese adolescents.

Methods: We performed a cross-sectional survey of 1,840 junior high school students using questionnaires. The subjects were classified into problem behavior (PB) or normal behavior (NB) groups by using the Pediatric Symptom Checklist. The scores of the sleep-related factors, sleep bruxism, lifestyle and food habits, and GERD symptoms were compared. Logistic regression analysis was performed to determine the factors related to problem behaviors.

Results: The mean age was 13.3 ± 1.8 years. The PB group had significantly longer sleep latency and higher scores of GERD symptoms ($P < 0.001$). Furthermore, the PB group was significantly more likely to experience absences of the mother at dinner time, skip breakfast, and have less than 30 min of conversation among family at dinner time. The PB group had significantly higher frequencies of sleep bruxism, difficulty falling asleep within 30 min, nightmares, feeling of low sleep quality, daytime somnolence, and daytime lack of motivation. Feelings of low sleep quality had the strongest association with problem behaviors, with an adjusted OR (95% CI) of 12.88 (8.99–18.46).

Conclusions: Our large-scale cross-sectional study found that problem behaviors in adolescents were associated with sleep problems, including sleep bruxism, as well as lifestyle and food habits and GERD symptoms.

Key words: behavioral symptom, sleep bruxism, sleep problem, GERD, psychology

Psychological problems are known to be common among adolescents. Epidemiologic studies have demonstrated high prevalence rates of psychological problems in American adolescents.[1] In Japan, the prevalence of psychological problems in adolescents is increasing, and has been associated with problem behaviors.[2] For example, in 2009, the Ministry of Education, Culture, Sports, Science and Technology of Japan issued a press release detailing a rise in severe problem behaviors in recent years, with incidents of juvenile violence and bullying. Additionally, concurrent problem behaviors such as school performance, school absenteeism, risk-taking behavior, injury, and impaired social functioning in children are associated with sleep problems.[3,4] In particular, sleep bruxism in children is associated with an increased incidence of attention-behavior problems, which may be associated with higher arousal.[5] Furthermore, sleep bruxism is significantly associated with chronic stress.[6] Some reviews reported that the association between emotional state and sleep, and that the association would be bidirectional.[7,8]

Gastroesophageal reflux disease (GERD) impairs daytime and nocturnal functioning. In the United States, at least 20% of adults experience heartburn once a week.[9] According to the American Gastroenterological Association, 79% of adult respondents in a survey reported experiencing heartburn at night, and the majority reported that nighttime heartburn resulted in sleeping difficulties and impaired daytime functioning.[10] A past research suggested that sleep

quality is related to the severity of reflux during sleep, and adult patients with nighttime heartburn and sleep complaints have greater acid contact times.[11] This study also indicated that poor sleep quality is associated with esophageal acid exposure of the following day.

To date, the literature focusing on the prevalence and symptoms of GERD in adolescents is scarce. Based on questionnaire reports in the United States, the prevalence of symptoms of heartburn and acid regurgitation in children was 1.8–8.2%.[12] In the United Kingdom, the incidence of GERD in children was 0.84 per 1000 persons/year.[13] Prevalence and symptom complexes vary according to geography and patient perception.[14] Therefore, there are few longitudinal reports evaluating GERD symptoms in children or adolescents. However, some studies suggest that GERD symptoms in childhood persist, and that these children are likely to experience GERD symptoms into adulthood.[15,16] Given this situation, it is important to investigate GERD symptoms among adolescents, as it may be useful for the future prevention and/or treatment of GERD symptoms in adults. In addition, it was reported that GERD symptoms may result in anxiety and depression.[14,17] In a word, there is a possibility that GERD symptoms may affect the problem behavior through psychological instability due to the anxiety or depression.

Considering the above-mentioned associations of problem behavior with sleep problems and sleep bruxism[3-8], association between GERD symptoms and sleep problems[10,11], association

between problem behavior and GERD symptoms[14,17], these relationships are assumed to have associations with adolescents' psychological well-being. Additionally, recent studies have reported an association between sleep bruxism and gastroesophageal reflux in adults.[18,19] Regarding this association, above-mentioned study[5] reported that problem behaviors are associated with bruxism, but that bruxism was not associated with GERD. Meanwhile, a noteworthy experimental study found that rhythmic masticatory muscle activity (RMMA) episodes including sleep bruxism were induced by esophageal acidification.[20] This study suggested that acid in the esophagus due to the gastroesophageal reflux possibly raise sleep bruxism in order to wash out the acid. Also, sleep bruxism is considered to be one of the factors of sleep problems.[21] Thus, we hypothesized that problem behavior has associations with sleep problems and bruxism, and GERD symptoms in adolescents. The aims of the present study are (i) to obtain the epidemiologic data of Japanese adolescents and (ii) to investigate the relationships of problem behavior with sleep problems and bruxism, and GERD symptoms.

Methods

Participants

The study protocol was approved by the Ethics Committee of Kagoshima University. Approval from the Regional Committee of Education in the Kagoshima prefecture in Japan was also

obtained. This study was carried out from September to October 2009 in 11 public junior high schools located in the Kagoshima prefecture in Japan. A total of 1,840 junior high school students aged 12–15 years and their parents agreed to participate in this study.

Procedure and Questionnaires

Information regarding the survey was provided to the principal and school teachers of each school, and their consent to cooperate with this study was obtained. Each information package consisted of a cover letter, a questionnaire, and an envelope to return the questionnaire. The questionnaire was distributed to participants through their schools and returned in a sealed envelope. Problem behavior, sleep patterns, lifestyle and food habits, and GERD symptoms that were most common during the past week were investigated using questionnaires as stated below. Also, basic demographics such as age, grade, and gender were collected.

Problem behavior

The Pediatric Symptoms Checklist (PSC) [22] was used to assess problem behaviors. The PSC is a 35-item questionnaire examining children's emotional and problem behaviors according to parents' impressions of their children's psychosocial functioning. The PSC has been widely used and evaluated nationally. The Japanese edition of the PSC was used, with a cutoff score of

17. [23] According to the study that designed the Japanese PSC, a cutoff score of 17 provided a sensitivity of 80% and a specificity of 90%. Subjects were divided into a normal behavior (NB) group and problem behavior (PB) group according to their PSC score.

Sleep-related factors, and lifestyle and food habits

Parents were asked about the most characteristic observation or hearing results, sleep behaviors, and lifestyle and food habits as described below. With regard to sleep-related factors, parents were asked about their children's bed time, sleep latency, sleeping hours, sleep bruxism, difficulty in falling asleep within 30 min, nightmares, feeling of low sleep quality, daytime strong somnolence, and lack of motivation. Over 3 episodes a week were required to consider an observation positive. With regard to lifestyle and food habits, parents were asked about the absence of father and/or mother at dinner time, the mother's employment for every day or over 3 times per week, parents' arriving home late over 3 times per week, skipping breakfast, less than 30 min of conversation among the family at dinner time, and having a late-evening snack. With the exception of the mother's employment and parents' arriving home late, over 3 episodes a week was required for a positive response.

GERD symptoms

GERD symptoms were assessed using the Frequency Scale for the Symptoms of Gastroesophageal reflux disease (FSSG) [24] through hearing by parents to children. Developed in Japan, the FSSG is used in the initial diagnosis of GERD. It comprises 12 questions concerning dyspeptic and dysmotility symptoms. Although the "Questionnaire for the diagnosis of reflux disease (QUEST)" [25] is also used in the initial diagnosis of GERD, its classification of symptoms as mild, moderate, or severe may be inappropriate for Japanese people.[24] Moreover, the content was not appropriate for adolescents. The FSSG evaluates 7 acid reflux-related symptoms (questions 1, 4, 6, 7, 9, 10, and 12) and 5 dysmotility-like symptoms (questions 2, 3, 5, 8, and 11). When the cutoff score for FSSG was set at 8, the sensitivity was 62%, the specificity was 59%, and the reliability was 60%.[24]

Statistics

Children were classified into a problem behavior group (PB group) or a normal behavior group (NB group) according to the cutoff score 17 in the PSC.[23] Statistical significance was determined using the Mann–Whitney *U*-test for continuous data or χ^2 test for categorical data. Logistic regression analysis was used to estimate the adjusted odd ratios (95% CI) for having problem behaviors in all subjects. All statistical analyses were performed using SPSS (SPSS 14.0 for Windows, SPSS Inc., Tokyo). A *P* value of <0.05 was considered statistically

significant.

Results

Of 1,840 students, 950 were female (51.6%), and the mean age was 13.3 ± 1.8 years. Response rate was 81%. Based on the PSC cutoff score, the NB group consisted of 1,580 students (85.9%), while the PB group had 260 students (14.1%). There was no difference in the male-female ratio between the 2 groups (Table 1). Table 2 displays the comparisons of continuous data. Compared to the NB group, the PB group had significantly longer sleep latency and higher FSSG scores ($P < 0.001$). There was no significant difference in bed time, sleeping hours. Table 3 shows descriptive statistics of results of FSSG. Although 4.2% of NB group showed that they are suspected of GERD, 23.8% of PB group are suspected of GERD. Fig. 1 shows the distribution of FSSG of each group. Table 4 shows the comparison of categorical data. The PB group had significantly greater sleep bruxism, difficulty in falling asleep within 30 min, nightmares, feeling of low sleep quality, daytime strong somnolence, and lack of motivation ($P < 0.001$). Furthermore, the PB group had significantly higher episodes of absence of mother at dinner time ($P < 0.016$), less than 30 min of conversation among the family at dinner time ($P < 0.001$), and skipping breakfast ($P < 0.001$). After adjusting for age and sex, sleep bruxism, sleep latency, nightmares, a feeling of low sleep quality, lack of motivation, less than 30 min of conversation

among the family at dinner time, and skipping breakfast were found to be significantly associated with problem behaviors. Among the sleep-related factors, a feeling of low sleep quality had the strongest association with problem behaviors with an adjusted OR (95% CI) of 12.88 (8.99–18.46), and among the lifestyle and food habits, less than 30 min of conversation among the family at dinner time had the strongest association, with an adjusted OR (95% CI) of 2.80 (1.32–5.99) (Table 5).

Discussion

According to the PSC, 260 students (male: 137; female: 123) were found to have problem behaviors (14%). This prevalence rate is fairly consistent with other studies those reported 12–14% of adolescents have psychosocial issues.[22,26,27] Our study found there was no difference in the results between males and females, which differs from another study that used the PSC.[22] The reason why there is a difference between the present study and past research remained unexplained. To elucidate the reason of the difference, extensive research is needed.

Problem behaviors and sleep bruxism

Previous studies have reported an association between psychological problems in adolescents and sleep disorders[28] and sleep bruxism[29,30] in particular. Our study found a significantly higher

frequency of sleep bruxism in the PB group (OR 3.28, 95% CI 2.29–4.69).

Micro-arousals usually occur prior to the onset of sleep bruxism.[31] Children with sleep bruxism demonstrate a higher arousal index, and also score higher on questionnaires inquiring about problem behaviors.[5,32] Studies have observed that emotional stress disturbs the quality of sleep.[33] Another study reported that such stress can affect the transitions of sleep stages.[34] In order words, sleep fragmentation may result in behavioral and attention problems.[35] Incomplete psychological well-being may decrease the quality of sleep, leading to bruxism. However, it remains unclear how emotional instability accompanied by problem behaviors physiologically affects the occurrence of bruxism. Sleep deterioration and problem behaviors might very well affect each other.

In our study, the PB group was found to have significantly longer sleep latency. Another study reported a tendency towards prolonged sleep latency and REM latency in children with sleep bruxism, although it was not statistically significant.[5] Emotional status has also been reported to affect the occurrence of arousals,[36] sleep fragmentation, and a prolonged REM period.[37,38] The emotional state of adolescents with problem behaviors may similarly affect and alter the content and/or quality of sleep. In our study, sleep bruxism was observed in 14.7% and 40.8% of the NB and PB groups, respectively. The estimated prevalence of bruxism ranges between 18%[29] and 5–20%.[39] Although the precise confirmation of muscle activities associated

with bruxism would require polysomnography evaluation, parental accounts of subjective sleep bruxism have been previously used in other studies and is considered reliable because their reports were based on nearly daily and continuous observation.[40] Behavioral and physiological verification will be necessary to elucidate the association between problem behaviors and bruxism. In addition, it is possible that GERD symptoms may be associated with the manifestation of bruxism, as we will discuss later.

Problem behaviors and sleep-related factors

Contrary to our expectation, there were no significant differences detected for bed time and sleeping hours. Bed time has been shown to have no significant association with problem behaviors.[3] A statistical survey in Japan[41] revealed that bed time is delayed and sleeping hours shortened by several factors, including sports activity, adding more academic teaching after school until late at night, and in adolescents, playing TV games and using the Internet in particular. These situations may not be different for the NB and PB groups and, thus, no significant difference was detected. Adolescents with emotional insecurities or psychological anxiety experience difficulty falling asleep and maintaining sleep.[3] In our study, the time required for the PB group to fall asleep was significantly longer than that for the NB group. Furthermore, the PB group had significantly more difficulty falling asleep within 30 min, and

experienced significantly more nightmares, feeling of low sleep quality, daytime strong somnolence, and lack of motivation. Moreover, regression analysis showed that the feeling of low sleep quality was strongly associated with problem behaviors. Past researches reported that eveningness tendency has associations with longer sleep latency, bad morning feeling, and daytime sleepiness[42], and that eveningness have associations with behavioral problems in adolescents.[43,44] Regarding the possible association between problem behavior and sleep-related factor, effect of daytime cortisol level was suggested.[44,45] Also, other possible associations have been reported. Micro-arousal, which often occur associated with gastroesophageal reflux[34], provides daytime sleepiness due to the deprivation of sleep[46], and decrease the quality of sleep.[47,48] Daytime somnolence observed in the present study has possibly association with this low quality of sleep. Symptoms such as difficulty falling asleep and feeling of low sleep quality are suggestive of deterioration of sleep quality. Indeed, these symptoms may be an expression of problem behaviors. However, further research will need to elucidate these associations.

Problem behaviors and lifestyle and food habits

The PB group had a significantly higher frequency of absent mothers at dinner time and less than 30 min of conversation among family at dinner time. There is little evidence demonstrating a causal relationship between family meal and problem behaviors. However, a school-based

survey about family meals and psychosocial well-being among American adolescents indicated that family meals are inversely related with substance abuse, low academic performance, and depressive symptoms.[49] One of the most important benefits of family meals is conversation, as it provides a sense of togetherness and relaxation and they engage in laughter as a family.[50] Mental calm and stability from the conversation may help decrease the psychological insecurity experienced by some adolescents. The presence of the mother may have a significant impact on the nature of the conversation during a family meal.

Skipping breakfast is a major issue because the resulting inadequate nutrition can lead to learning problems and decreased daytime concentration.[51] A statistical survey conducted by the Health, Labour and Welfare Ministry of Japan in 2010 reported that the prevalence rates of skipping breakfast were 5.6% and 5.2% in males and females aged 7–14 years, respectively. Among those aged 15–19 years, the prevalence rates were 14.5% and 14.0% for males and females, respectively, and the rates continued to increase until the fourth decade of life. Recently, a problem behavior called “Kireru” among Japanese adolescents has become a social issue. These adolescents become easily angered and are unable to control their feelings. According to a survey of junior and high school students in suburban areas, those who had breakfast were likely to have a decreased frequency of “Kireru”.[52] Also, the School Breakfast Program showed significant associations between eating breakfast and school performance,

self-esteem, and psychosocial function.[53] Few studies have examined how skipping breakfast may be associated with psychological insecurity.[54] However, in our study, skipping breakfast was associated with not only problem behaviors but also daytime lack of motivation. Further research is required to better delineate these associations.

Problem behaviors and GERD symptoms

GERD is characterized by the reflux of gastric contents into the esophagus, leading to several symptoms and/or complications. In Japan, the prevalence rate of GERD has been steadily increasing and now surpasses 30%.[55] Results of the present study showed that 7 % of the participants have GERD symptom. Prevalence rate is nearly equal to the results of past researches.[12,13] Also, contrary to that 4.2 % of NB group got higher than cut off point (8) for GERD symptoms, 23.8 % of PB group indicated those symptoms. Comparing with the prevalence rate of the adults reported in Japan[55], this high rate of PB group as adolescents deserves attention. To our knowledge, large scale data of GERD symptom in Japanese adolescents is scarce. The data of the present study have clinical significance.

Several studies have suggested that GERD symptoms are associated with psychological problems, reporting that these symptoms may result in anxiety and/or depression due to the discomfort caused by reflux.[14,17] Those studies indicated that psychiatric disorders such as

anxiety or depression can influence an individual's perception of reflux symptoms, thus potentially leading to discomfort the following day. GERD events during sleep have been reported to increase micro-arousals.[56] Regarding the effect of GER symptoms, an experimental research found that frequencies of electromyography bursts, rhythmic masticatory muscle activity (RMMA) episodes, and grinding noise were significantly higher after an acidic infusion than after a saline infusion, and that RMMA episodes including sleep bruxism were induced by esophageal acidification.[20]

As described in the section of "`Problem behaviors and sleep-related factors", occurring of micro-arousal associated with gastroesophageal reflux might provide sleep deprivation and the decrease of sleep quality. Hence, discomfort and/or depression due to GERD symptoms, and decrease of sleep quality are possibly associated with problem behavior. We believe that further researches including physiological experiments will elucidate these associations and will contribute to the treatment of problem behavior of adolescents.

Conclusion

Our large-scale cross sectional study on Japanese junior high school students found that problem behaviors in adolescents are associated with some sleep problems, including sleep bruxism, as well as several surroundings of lifestyle and food habits and GERD symptoms. The

presence of problem behaviors should prompt medical personnel to investigate possible GERD symptoms and sleep bruxism and parents to pay closer attention to these developments.

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Table 1 Male-female ratio in each group

Gender	NB* group (n = 1580)		PB** group (n = 260)		Difference	
	n	%	n	%	χ^2 value	*P* value
Male	753	47.7	137	52.7	0.27	NS
Female	827	52.3	123	47.3		

*NB: normal behavior, **PB: problem behavior, n: number

Table 2 Comparison of continuous variables

Continuous variables	NB* group (n = 1580) mean ± SD	PB** group (n=260) mean ± SD	$Z^{\dagger}$	$P^{\dagger\dagger}$
Sleep and GERD related factors				
Bed time (h)	10.3 ± 2.7	10.3 ± 2.8	-1.532	0.126
Sleep latency (min)	12.7 ± 10.7	18.0 ± 14.6	-5.388	<0.001
Sleeping hours (h)	7.1 ± 0.9	7.1 ± 1.0	-0.587	0.557
FSSG score (points)	1.4 ± 2.6	4.8 ± 4.9	-13.627	<0.001

*NB: normal behavior , **PB: problem behavior

$Z^{\dagger}$: Z value, $P^{\dagger\dagger}$: P value

Table 3 Descriptive statistics of results of FSSG*

NB ** group (n = 1580)				PB*** group (n = 260)			
FSSG		number of higher than cutoff point#		FSSG		number of higher than cutoff point#	
Range	Median	n	%	Range	Median	n	%
0-21	0	66	4.2	0-27	14	62	23.8

* FSSG: Flequency Scale for GERD symptoms, **NB: normal behavior, ***PB: problem behavior, #: 8 point (It means suspision for GERD)

Table 4 Comparison of categorical variables

Categorical variables	NB group (n = 1580) %	(n)	PB group (n = 260) %	(n)	$\chi^{2\dagger}$	$P^{\dagger\dagger}$
Sleep-related factors						
Sleep bruxism	14.7	233	40.8	106	100.59	<0.001
Difficulty falling asleep within 30 min	5.9	93	20.8	54	67.28	<0.001
Nightmare	1.1	18	9.2	24	65.54	<0.001
Feeling of low sleep quality	5.9	94	57.3	149	513.76	<0.001
Daytime somnolence	4.1	64	20.8	54	103.98	<0.001
Daytime lack of motivation	3.0	47	28.8	75	241.38	<0.001
Lifestyle and food habits						
Absence of father at dinner time	13.1	207	17.3	45	3.34	0.068
Absence of mother at dinner time	3.2	50	6.2	16	5.77	0.016
Less than 30 min of conversation among family at dinner time	2.5	39	6.2	16	10.46	0.001
Mother employment (everyday or over three times per week)	28.5	450	31.5	82	1.02	0.314
Late home arrival of parents (over three times per week)	4.4	70	5.8	15	0.91	0.341
Taking late-evening snack	9.0	142	10.8	28	0.85	0.358
Skipping breakfast	11.5	182	25.4	66	36.81	<0.001

*NB:normal behavior , **PB: problem behavior

$\chi^{2\dagger}$: Pearson's chi-square test value, $P^{\dagger\dagger}$: P value

Table 5 Logistic regression analysis for the risks of problem behavior

Variables	Adjusted OR*	95% CI **
Sleep bruxism	3.28	2.29-4.69
Sleep latency (min)	1.02	1.00-1.03
Nightmare	3.21	1.32-7.80
Feeling of low sleep quality	12.88	8.99-18.46
Daytime lack of motivation	5.79	3.46-9.71
Less than 30 min of conversation among family at dir	2.80	1.32-5.99
Skipping breakfast	1.66	1.08-2.55

*OR: odds ratio, **CI: confidence interval

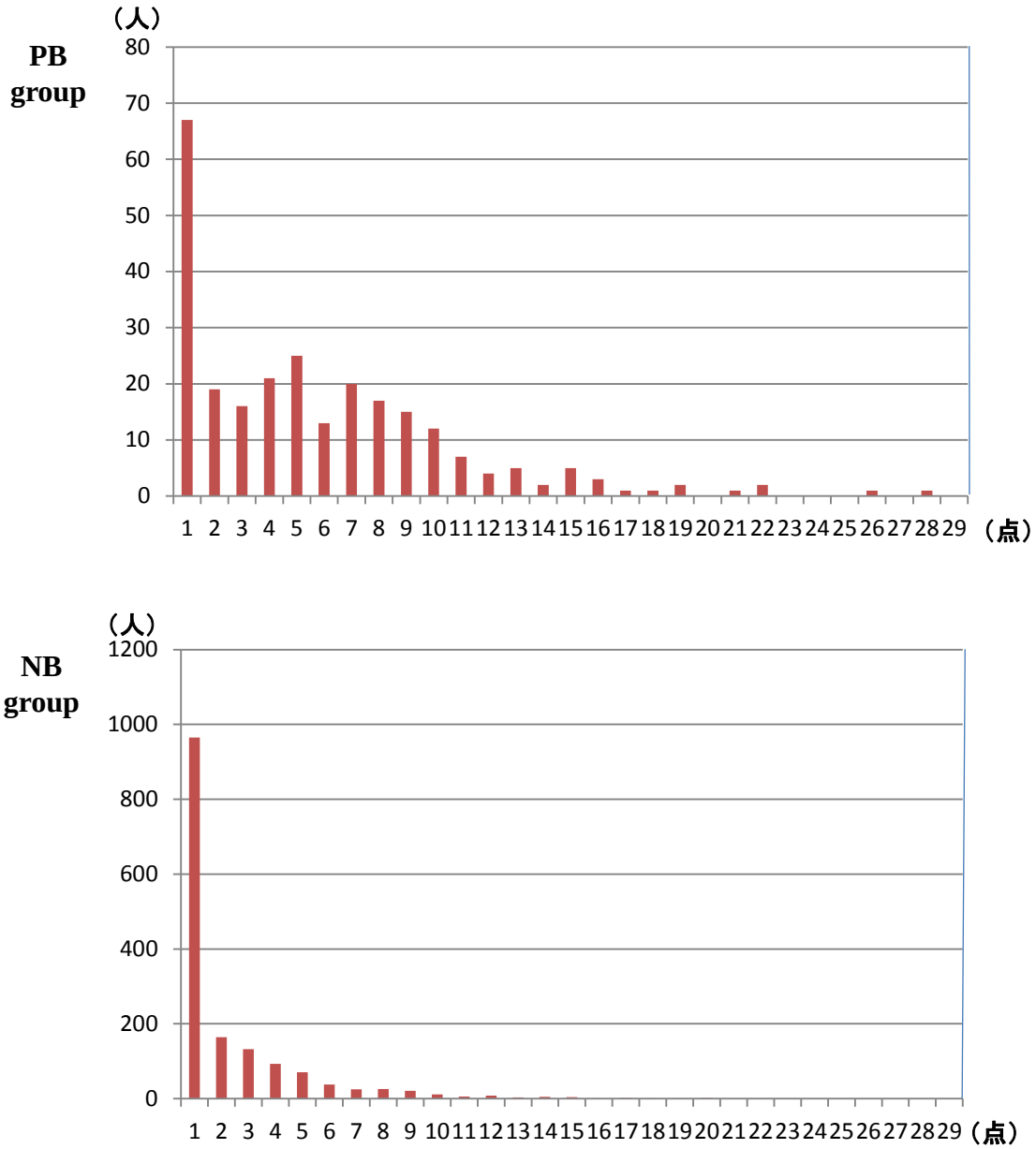

Fig. 1 Distribution of FSSG in the Problem Behavior (PB) group and Normal Behavior (NB) group.