

Reliability and Validity of the Japanese Version of the Physical Activity Questionnaire for Older Children

Clinical Medicine Insights: Pediatrics
Volume 13: 1–6
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DOI: 10.1177/1179556519835833



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ABSTRACT

OBJECTIVES: This study aimed to examine the reliability and validity of the Japanese version of the Physical Activity Questionnaire for Older Children (PAQ-C) in Japanese children aged 9 to 12 years.

METHODS: A total of 210 children aged between 9 and 12 years participated. Internal consistency and test-retest reliability were evaluated using Cronbach alpha coefficient and intraclass correlation coefficient (ICC), respectively. Validity was evaluated using athletic competence (AC), self-efficacy (SE), body mass index (BMI), body fat percentage (%BF), cardiovascular fitness (CVF), and World Health Organization Health Behavior in School-aged Children (WHO HBSC) physical activity questionnaire.

RESULTS: Internal consistency was acceptable ($\alpha=0.80$) and test-retest reliability showed excellent agreement ($ICC=0.83$). The PAQ-C score was significantly correlated with AC ($r=0.41$), SE ($r=0.65$), %BF ($r=0.19$), and CVF ($r=-0.32$). The PAQ-C score of the active group classified by the WHO HBSC physical activity questionnaire (mean score \pm standard deviation [SD] = 3.03 ± 0.57) was significantly higher than that of the inactive group (mean score \pm SD = 2.27 ± 0.63 , $P<.01$).

CONCLUSIONS: The PAQ-C had acceptable reliability and validity. The PAQ-C is a useful instrument to evaluate physical activity for Japanese children aged 9 to 12 years.

KEYWORDS: validity, reliability, self-reported, physical activity, older children

RECEIVED: July 17, 2018. **ACCEPTED:** February 5, 2019.

TYPE: Original Article

FUNDING: The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This research was supported by the Sasakawa Sports Research Grant from Sasakawa Sports Foundation [grant number 180B3-042]. The author(s) confirm that the funder had no influence over the study design, content of the article, or selection of this journal

DECLARATION OF CONFLICTING INTERESTS: The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Introduction

Physical inactivity is a known risk factor for obesity and cardiovascular diseases.^{1,2} Physical inactivity in childhood is known to influence the physical activity (PA) level and obesity in adulthood, and thus has been associated with lifestyle-related diseases in adulthood.^{3–5} Engaging in regular PA in childhood is inversely related to body fat percentage, positively related to cardiovascular fitness (CVF), and negatively related to depression.^{6–8}

Some objective and subjective measurements of PA for children have been suggested as reliable and valid methods.⁹ Objective measurements such as those using accelerometers are accurate; however, these are difficult to use in population-based studies as their high costs make them impractical tools. In addition, there may be adherence issues such as forgetting to wear the measuring devices. A self-reported questionnaire is one of the subjective measurements most commonly used to evaluate PA in children. It can be applied at low costs, without specialized staff, and with low participant burden. In addition, such questionnaires are

relatively quick to answer. Thus, such tools enable us to investigate a large sample of children in a short period.⁹

The Physical Activity Questionnaire for Older Children (PAQ-C) was developed to evaluate the level and the frequency of moderate-to-vigorous PA (MVPA) in children between 8 and 14 years of age.¹⁰ The PAQ-C includes questions on the activity level during physical education classes, recess, lunch, after-school activities, in the evenings, and on weekends. It has been reported that the PAQ-C has good internal consistency, test-retest reliability, and construct and discriminant validity.^{9,10} The previous study investigated a calibration model with PAQ-C.¹¹ Recently, the PAQ-C has been translated into diverse languages representing various countries around the world, and its validity and reliability has been proved.^{12–15} Furthermore, it has been reported that the PAQ-C can be applied to the PA assessment tool in overweight and obese children.¹⁶ However, the PAQ-C has not been translated into Japanese and no existing studies have examined the reliability



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and validity of the Japanese version of the PAQ-C. Therefore, the purpose of this study was to translate the PAQ-C into Japanese and to examine the reliability and validity of the Japanese version in Japanese children aged 9 to 12 years. In this study, we examined the construct validity with athletic competence,¹⁷ self-efficacy for PA,^{18,19} body mass index (BMI),²⁰ body fat percentage,²⁰ and CVF.²¹

Methods

Translation of the PAQ-C into Japanese

The original PAQ-C was translated and back-translated into Japanese and was cross-culturally adapted. The translation and cross-cultural adaptation was conducted in accordance with the internationally recommended guidelines.^{22,23} First, we contacted the original author to confirm that the PAQ-C was not being translated into Japanese and to obtain permission to use it and translate it into Japanese. We modified some sport activities in the first question because of the socio-cultural differences in the background. For example, rowing/canoeing, aerobics, street hockey, floor hockey, ice skating, cross-country skiing, and ice hockey/ringette were excluded because these sport activities are not popular in Japan. Activities such as dodgeball, playing at the playground, athletic sports, tennis, gymnastics, budo (judo, kendo, karate, sumo, among others), and skiing/snowboarding are popular in Japan and were added in the Japanese version of the PAQ-C. Educators with teaching licenses and researchers discussed the modified items to ensure that these were appropriate for the cultural environment in Japan. For reference, we used the report that investigated the player population of each sporting event among children in 2014.²⁴ Then, the forward translation of the original PAQ-C into Japanese was performed by a competent person who has a bachelor's degree in English. Back-translation was carried out by a bilingual speaker, who was blinded to the original PAQ-C. Then, the back-translated PAQ-C was checked against the original PAQ-C by native English speakers and the original author. The translated PAQ-C was tested in a pilot study of 10 Japanese children (8-12 years of age) to confirm whether they fully understood all items and did not have any difficulties in understanding the meaning of the phrasing for each item. We reviewed the results of cognitive debriefing and modified the translated PAQ-C as appropriate. Subsequently, the original author approved the modified parts. The final Japanese version of the PAQ-C was proofread to correct any errors if needed.

Data collection

Participants. In this study, 210 children aged 9 to 12 years were enrolled from two public elementary schools in Kobe, Japan, using typical case sampling. First, 10 children who did not complete the measurements to be analyzed and 16 children who answered with a "yes" to question no.10 in the questionnaire (Japanese version of the PAQ-C) regarding their

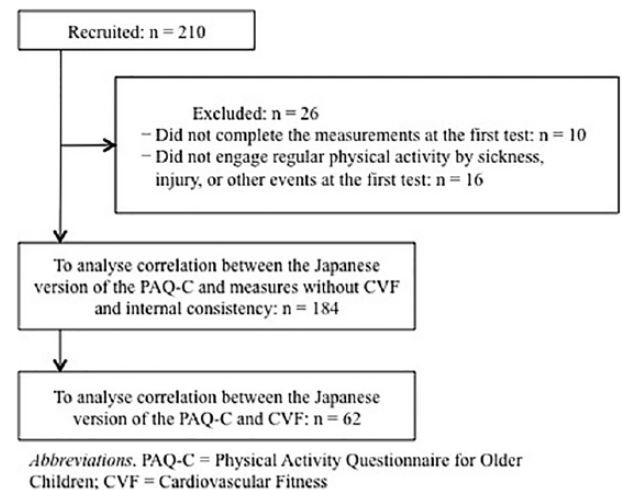


Figure 1. Flowchart of children recruited for and participating in the analysis of validity and internal consistency of the Japanese version of the PAQ-C.

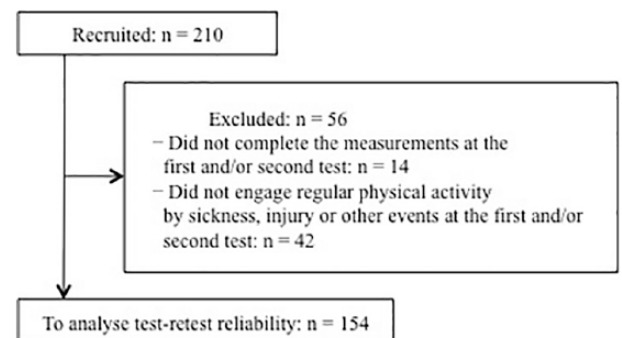


Figure 2. Flowchart of children recruited for and participating in the analysis of test-retest reliability of the Japanese version of the PAQ-C.

inability to perform regular PA during the past week because of sickness, injury, or other reasons at the first assessment were excluded from the study. A total of 184 children were finally included to explore the validity and internal consistency of the Japanese version of the PAQ-C (Figure 1). Of these children, 64 were included in the analysis of correlations between the Japanese version of the PAQ-C and CVF. Then, 14 children who did not have complete measurements at the first and/or second assessment and 42 children who answered with a "yes" to question no.10 at the second assessment were also excluded. This resulted in a final sample size of 154 children for the analysis of test-retest reliability (Figure 2).

Procedures. First, children answered the questionnaire including the Japanese version of the PAQ-C and other assessments, and we measured the participants' height, weight, body fat percentage, and CVF. After 2 months of the assessment, the children answered the Japanese version of the PAQ-C again to explore the test-retest reliability. Both the assessments were conducted under the same conditions and monitored by the same administrators. Assistants supported children who could

answer the Japanese version of the PAQ-C accurately. For the measurement of weight, body fat percentage, and CVF, one assistant measured one child. Height was also measured by one elementary school teacher per child. This study was conducted based on the Helsinki Declaration. We explained the study protocol to the principals of the participating elementary schools and teachers in charge of the students before obtaining the measurements. Verbal informed consent, along with the informed consent and assent form, was obtained from all guardians and participants by the investigator and teachers from each participating school. The protocol of this study was reviewed by the Research Ethics Committee and approved by the President of Kobe University Graduate School of Health Sciences (approval no. 431).

Assessments

PAQ-C scoring. The PAQ-C is a self-administered questionnaire that evaluates MVPA levels in past 7 days (in the last week) in children aged between 8 and 14 years.¹⁰ It should be used during regular classes as some questions refer to activities in school. In the PAQ-C, PA is defined as sports, games, or dance activities that “make you sweat” or “breathe hard,” or “make your legs feel tired.” The PAQ-C consists of 10 items, of which 9 items are used to calculate the total activity score. The 10th question asks whether the child was sick, injured, or experienced any other events that precluded him or her from engaging in regular PA the week prior to completing the questionnaire. Participants were asked to answer each of the nine items using a 5-point scale (scoring for each item from 1-5). The PAQ-C score was calculated as the mean score of the nine items, ranging from 1 to 5. Higher scores indicated greater PA levels.

World Health Organization Health Behavior in School-aged Children physical activity questionnaire. The Japanese version of the World Health Organization Health Behavior in School-aged Children (WHO HBSC) physical activity questionnaire was used to determine the discriminant validity for the Japanese version of the PAQ-C. The WHO HBSC physical activity questionnaire evaluates the frequency of exercises and the duration over the last week.²⁵ This questionnaire consists of two items: frequency and duration. The frequency is assessed through the question “Outside school hours: How often do you usually exercise in your free time, so much that you get out of breath or sweat?” The response alternatives were “Once a month or less,” “Once a week,” “2-3 times a week,” “4-6 times a week,” or “Everyday.” The duration of PA was assessed by the following question related to the item “Outside school hours: How many hours do you usually exercise in your free time, so much that you get out of breath or sweat,” and the answers were “None,” “About half an hour per week,” “About 1 hour per week,” “About 2-3 hours per week,” “About 4-6 hours per week,” and “About 7 hours per week.” Participants who answered “Once a month or less” or “Once a week” in the frequency item

or “None” or “About half an hour per week” in the duration item were classified as an inactive group. Participants who answered “2-3 times a week” or more in the frequency item and “About 1 hour per week” or more in the duration item were classified as an active group.²⁶

Athletic competence. Athletic competence was evaluated using the athletic competence scale of the Japanese version of the SPPC.²⁷ The SPPC evaluates self-esteem in children in five domains. Athletic competence, which is one of the five domains, refers to one’s ability to do well at sports or outdoor games, demonstrating one’s athletic prowess.²⁸ The scale consists of six items, for example, “Are you very good at sports and gymnastics?” Each item is scored on a 4-point scale, with higher scores indicating a more positive view of one’s self. The total score of the athletic competence scale ranges from 6 to 24.

Self-efficacy. Self-efficacy for PA was evaluated using the Japanese version of the PA self-efficacy scale for children.²⁹ Self-efficacy for PA refers to one’s confidence in his or her ability to perform the target PA under difficult conditions.³⁰ The scale consists of eight items, for example, “I am confident that I can be physically active outdoors even if it is a cold or hot day.” Each item is scored on a 5-point scale, with higher scores indicating greater self-efficacy levels. The total score for the self-efficacy scale ranges from 8 to 40.

Body composition. Weight (accurate to 0.1 kg) was measured using a digital scale (InBody 430 analyzer; Biospace Co. Ltd, Seoul, Korea). Height (accurate to 0.1 cm) was measured at the Health Examination held on a regular basis at each elementary school. Body mass index was calculated as weight (in kg) divided by height (in m²) using the measured height and weight. Body fat percentage was measured using bioelectrical impedance analysis (InBody 430 analyzer; Biospace Co. Ltd).³¹

Cardiovascular fitness. Cardiovascular fitness was evaluated using the YMCA 3-Minute Step Test, which requires children to step up and down using an up-up-down-down pattern on a 0.305-m bench at a rate of 24 rises/min paced by a metronome set at 96 beats/min.³² After 3 minutes of stepping, children immediately sat down on a chair and remained still. Starting within 5 seconds, children’s heart rate was counted for 1 minute by physical therapists. The heart rate for 1 minute was used as the CVF score,³² with a lower score indicating better CVF.

Statistical analysis

The data were statistically analyzed using the STATA software version 14.0 (StataCorp, College Station, TX, USA). Differences in participants’ characteristics between sex were compared using an unpaired *t*-test for parametrical variables including age, height, and athletic competence; the Wilcoxon rank sum test for non-parametrical variables including weight,

Table 1. Demographic characteristics of the participants.

VARIABLES	ALL (N=184)	MALE (N=104)	FEMALE (N=80)
Age (years)	10.9 ± 0.9	10.8 ± 1.0	11.0 ± 0.9
Height (cm)	143.5 ± 7.5	142.9 ± 7.5	144.3 ± 7.4
Weight (kg)	36.7 ± 7.1	36.5 ± 7.3	37.1 ± 6.8
BMI (kg/m ²)	17.7 ± 2.4	17.7 ± 2.5	17.6 ± 2.2
PAQ-C _{score} (1.00-5.00)*	2.76 ± 0.69	2.84 ± 0.70	2.65 ± 0.68
WHO HBSC PAQ (%)			
Active	63.6	66.4	60.0
Inactive	36.4	33.7	40.0
Athletic competence (6-24)	14.3 ± 3.4	14.5 ± 3.3	14.1 ± 3.4
Self-efficacy (8-40)	28.7 ± 7.2	28.8 ± 6.5	28.5 ± 7.9
Body fat percentage	17.7 ± 7.4	16.5 ± 7.9	19.3 ± 6.3
CVF (bpm _{post-exercise})	92.8 ± 15.8	90.1 ± 14.1	97.2 ± 17.6

Abbreviations: BMI, body mass index; PAQ-C, Physical Activity Questionnaire for Older Children; WHO HBSC PAQ, World Health Organization Health Behavior in School-aged Children Physical Activity Questionnaire; CVF, cardiovascular fitness (YMCA 3-Minute Step Test); bpm, beats per minute.

Only 62 children (male, N=38; female, N=24) were evaluated for CVF.

* $P < .05$.

Table 2. Test-retest reliability of the Japanese version of the PAQ-C scores (N=154).

	ASSESSMENT 1	ASSESSMENT 2	ICC (95% CI)
PAQ-C _{score} (1.00-5.00)	2.74 ± 0.70	2.70 ± 0.75	0.83 (0.77-0.88)

Abbreviations: PAQ-C, Physical Activity Questionnaire for Older Children; ICC, intraclass correlation coefficient; CI, confidence interval.

Assessments 1 and 2 correspond to the first and second applications of the Japanese version of the PAQ-C, respectively.

BMI, the Japanese version of the PAQ-C score, self-efficacy for PA, and body fat percentage; and a chi-square test for categorical variables including WHO HBSC physical activity questionnaire.

Internal consistency was evaluated using Cronbach alpha coefficient.³³ The coefficient values ≥ 0.70 were considered acceptable.³⁴

Test-retest reliability was evaluated using the intraclass correlation coefficient (ICC; one-way random-effects model).³⁵ The values of ICC were recommended as follows: values < 0.40 were considered as poor agreement, 0.40 to 0.75 were considered as fair-to-good agreement, and > 0.75 were considered as excellent agreement.³⁶

To determine the construct and discriminant validity, correlations between the Japanese version of the PAQ-C and athletic competence, self-efficacy, BMI, body fat percentage, and CVF were evaluated using Spearman rank correlation coefficient (ρ), and PAQ-C scores among WHO HBSC physical activity questionnaire groups were compared using the Wilcoxon rank sum test. As a reference, we used a method to determine the discriminant validity of the scores among

different groups.³⁷ The level of significance for all statistical analyses was set at $P < .05$.

Results

Participants' characteristics divided by sex are shown in Table 1. The mean score of the Japanese version of the PAQ-C was significantly higher in males than that in females (mean score \pm standard deviation [SD]: male = 2.84 ± 0.70 , female = 2.65 ± 0.68 ; $P < .05$).

Regarding internal consistency, Cronbach alpha coefficient was 0.80. Regarding test-retest reliability, the mean \pm SD scores for the first and second Japanese versions of the PAQ-C and ICC and 95% confidence interval (CI) are shown in Table 2. The ICC value (95% CI) was 0.83 (0.77-0.88).

Regarding the construct and discriminant validity, correlations between the Japanese version of the PAQ-C and athletic competence, self-efficacy, BMI, body fat percentage, and CVF are shown in Table 3. The Japanese version of the PAQ-C was significantly correlated with athletic competence ($r = 0.41$, $P < .01$), self-efficacy ($r = 0.65$, $P < .01$), body fat percentage ($r = -0.19$, $P < .01$), and CVF ($r = -0.32$, $P < .05$), but was not

Table 3. Correlations between the Japanese version of the PAQ-C and assessments.

	AC	SE	BMI	%BF	CVF
PAQ-C _{score}	0.41**	0.65**	-0.09	-0.19**	-0.32*

Abbreviations: PAQ-C, Physical Activity Questionnaire for Older Children; AC, athletic competence; SE, self-efficacy; BMI, body mass index; %BF, body fat percentage; CVF, cardiovascular fitness (YMCA 3-Minute Step Test).
* $P < .05$; ** $P < .01$.

significantly correlated with BMI ($r = -0.09$, $P = .21$). The Japanese version of the PAQ-C score of the active group classified by the scores of the WHO HBSC physical activity questionnaire (mean score \pm SD = 3.03 ± 0.57) was significantly higher than that of the inactive group (mean score \pm SD = 2.27 ± 0.63 , $P < .01$).

Discussion

This study aimed to examine the reliability and validity of the Japanese version of the PAQ-C in Japanese children aged 9 to 12 years. The mean score of the Japanese version of the PAQ-C was significantly higher in males than in females. Internal consistency and test-retest reliability were found to be acceptable, with excellent agreement. Regarding the construct validity of the Japanese version of the PAQ-C, the PAQ-C was found to be significantly correlated with athletic competence, self-efficacy, body fat percentage, and CVF. Furthermore, the significant difference between groups classified by scores of the WHO HBSC physical activity questionnaire suggested the discriminant validity of the Japanese version of the PAQ-C.

In this study, we observed sex differences in the level of PA, which was consistent with previous studies.^{9,38} The study exploring the validity of original PAQ-C showed the same differences in PA between males and females.⁹ Furthermore, Sallis³⁸ investigated the epidemiology of PA among children and suggested that males were more active than females. Our study is considered to be supported by this evidence.

We examined the internal consistency and stability of the Japanese version of the PAQ-C. The value of Cronbach alpha coefficient of the Japanese version of the PAQ-C in this study was similar to that of original PAQ-C in previous study⁹ and considered acceptable to internal consistency.³⁴ The ICC of the Japanese version of the PAQ-C was also similar to that of the original PAQ-C⁹ and indicated excellent agreement to stability.³⁶ These suggested that the Japanese version of the PAQ-C is a reliable tool for assessing PA in children aged 9 to 12 years.

This study indicated the construct validity of the Japanese version of the PAQ-C. The original PAQ-C was reported to be significantly correlated with athletic competence ($r = 0.48$).¹⁰ Our study showed a similar trend in the correlation between the Japanese version of the PAQ-C and athletic competence. The relationship between self-efficacy and body fat percentage, and PA has been reported.³⁹⁻⁴¹ Ling et al⁴¹ found

that self-reported PA was correlated with self-efficacy among children between 8 and 11 years of age ($r = 0.41$). Among Japanese children, Uechi et al³⁹ reported that self-efficacy for PA was related to PA among physical education classes, recess, lunch time, right after school, and in the evenings. Accordingly, our study suggested that self-efficacy was related to PA measured by the Japanese version of the PAQ-C. Lee et al⁴⁰ reported that the Malay version of the PAQ-C was related to body fat percentage, which was also in accordance with our study results. The Japanese version of the PAQ-C showed a significant but low correlation with CVF. Baranowski et al²¹ reported a similar relationship between PA and CVF in childhood. The original PAQ-C was also significantly correlated with the heart rates from the step test ($r = 0.28$).¹⁰ The results of our study showed a significant and positive association with CVF, as reported by the original study, which suggests that our results supported the construct validity of the Japanese version of the PAQ-C. However, BMI was not related to the Japanese version of the PAQ-C. Moore et al¹⁴ reported that BMI among European American children was significantly related to PAQ-C ($r = -0.16$), whereas no relationship was noted for African American children ($r = 0.01$). Furthermore, a previous study on Japanese children suggested that BMI was not related to self-reported PA, which is consistent with the results of our study.⁴² Thus, the relationship between the PAQ-C and BMI may differ by ethnicity. The mean score of the Japanese version of the PAQ-C in the active group was significantly greater than that in the inactive group. This result supported the discriminant validity of the Japanese version of the PAQ-C.

Some limitations should be considered in this study. First, to assess test-retest reliability, the original PAQ-C was retested over a 1-week interval. In contrast, in our study, we implemented the second assessment 2 months after the first assessment. Meyer et al⁴³ reported that 8 to 15 weeks is an appropriate interval to minimize a learned response while answering a questionnaire in a study examining ICCs by different retest intervals. Furthermore, in this study, both assessments were carried out during the same season and regular classes. Thus, we considered that the influences by learned response, season, and condition were minimal in both assessments, and we thoroughly assessed test-retest reliability. Second, we did not assess PA by objective measurements. The accelerometer measurement may be a preferable method for validation, but some previous studies have reported that validation can also be analyzed by CVF, which is an indirect method of self-reported validation.^{9,44} We considered further studies to examine the correlation between PA evaluated by the Japanese version of the PAQ-C and objective measurements among children aged 9 to 12 years. Third, the method of sampling to enroll from two public elementary schools, such as the typical case sampling, introduced the potential for selection bias. In addition, CVF could only be measured from one school of the 6th grade children. These numbers may limit generalizability. Thus, further

studies are warranted to investigate the validity and reliability of the Japanese version of PAQ-C in a larger sample population including several schools.

Conclusions

Our results indicate that the Japanese version of the PAQ-C is a reliable and valid questionnaire for the assessment of PA among Japanese children aged 9 to 12 years. We consider that the Japanese version of the PAQ-C will be a useful tool, particularly in the field of epidemiological research, to evaluate MVPA levels in Japan.

Acknowledgements

The authors sincerely appreciate the assistance of Mr Nobuyuki Nakatsu, Mr Yoshiya Nakamura, the teachers of elementary schools, and all participating children for their cooperation. The authors thank Crimson Interactive Pvt. Ltd (Ulatus, www.ulatus.jp) for their assistance in manuscript back-translation and editing.

Author Contributions

TI, RS, KT, SM, and RO conceived and designed the study methods; TI, RS, KT, SM, TS, AE, YK, YT, AF, and RO performed the study methods; TI analyzed the data and wrote the first draft of the manuscript; and RS and RO supervised the project. All authors discussed the results and contributed to the final manuscript and confirm that they meet the International Committee of Medical Journal Editors' criteria for authorship.

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