ADAPTATION AND REPRODUCIBILITY OF A QUESTIONNAIRE TO ASSESS PHYSICAL ACTIVITY IN EPIDEMIOLOGICAL STUDIES AMONG YAQUI INDIANS FROM SONORA, MÉXICO.

ADAPTACIÓN Y REPRODUCIBILIDAD DE UN CUESTIONARIO PARA EVALUAR LA ACTIVIDAD FÍSICA EN ESTUDIOS EPIDEMIOLÓGICOS ENTRE LOS INDIOS YAQUI DE SONORA, MÉXICO.

Serna Gutiérrez Araceli*, Esparza-Romero Julián*

*Research Center for Food and Development A.C., Public Nutrition and Health Department and Technological Institute of Sonora, México.

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ABSTRACT

Introduction: Due to the benefits of physical activity (PA) for health and the associated risk of physical inactivity with obesity and non-communicable diseases, the evaluation of PA is of great interest in public health. **Objective:** Was adapt and evaluate the reproducibility of a questionnaire to assess PA in epidemiological studies among Yaqui Indians from Sonora, México. **Methods:** The participants were 100 Indians from the 9 Yaquis communities, including men and women aged 20 or older. The adaptation phase of the PA questionnaire (PAQ) was done by interviewing 40 Yaquis about their activities related to leisure-time, occupation and transportation. For the reproducibility analysis, the PAQs applied by duplication to 60 adults were evaluated by the Spearman Correlation Coefficient (ρ) and Intraclass Correlation Coefficient (ICC). The level of agreement was evaluated by the Bland-Altman plot. **Results** Eighteen leisure time activities, 34 occupational activities, and 5 transportation activities were included in the PAQ. Very strong correlations were found for total leisure-time and occupational activities (ρ =0.92 and ρ=0.88, respectively; $p<0.0001$), and sedentary behaviors (ρ=0.94; $p<0.0001$) for the previous 12 months. The Bland-Altman plots indicated high agreement between PAQs. **Conclusions:** The adapted PAQ had high reproducibility for measuring PA in the Yaqui Indian population.

Key words: Ethnic groups; México; physical activity questionnaire.

RESUMEN

Introducción: Debido a los beneficios de la actividad física (AF) en la salud y la asociación de la inactividad física con la obesidad y las enfermedades no transmisibles, evaluar la AF es de gran relevancia para la salud pública. **Objetivo:** Adaptar y evaluar la reproducibilidad de un cuestionario para medir la AF en estudios epidemiológicos de adultos Yaquis de Sonora, México. **Material y Métodos:** Se incluyeron 100 Yaquis (hombres y mujeres) de 9 localidades con edad igual o mayor a 20 años. Para la adaptación del cuestionario de AF (CAF) se entrevistaron a 40 participantes sobre sus actividades recreativas, ocupacionales y de transporte. Para la reproducibilidad, los CAFs aplicados por duplicado a 60 Yaquis fueron evaluados por Correlación de Spearman (ρ) y Correlación Intraclase (CI). La concordancia fue analizada por gráfico de Bland-Altman. **Resultados:** Dieciocho actividades de tiempo libre, 34 ocupacionales y 5 de transporte fueron incluidas en el CAF. Se encontraron correlaciones fuertes para actividades del tiempo libre y ocupacionales, así como hábitos sedentarios (ρ=0.92, ρ=0.88, ρ=0.94; respectivamente; $p<0.0001$) para los 12 meses previos. Los gráficos de Bland-Altman indicaron un alto nivel de concordancia entre los CAFs. **Conclusiones:** El CAF adaptado tuvo alta reproducibilidad para medir la AF en Yaquis

Palabras Clave: Grupos étnicos; México; cuestionario de actividad física

Introduction
It is well known that PA has great health benefits (Foulds, Bredin, Charlesworth, Ivey & Warburton, 2014; Janssen, & LeBlanc, 2010; WHO, 2010) and that physical inactivity is a primary risk factor for the development of obesity (Golubic et al., 2015; Maher, Mire, Harrington, Staiano, & Katzmarzyk, 2013; Wanner et al., 2016) and No Communicable Diseases, causing 5.3 million deaths per year worldwide (Lee et al., 2012; Sallis et al.,2016). Due to the importance of PA in preserving health, mainly by promoting weight loss (Jakicic et al., 2014; Mekary et al., 2015; WHO, 2010), its evaluation is of great interest (Hallal et al., 2016). There are different methods for the evaluation of PA, such as questionnaires, doubly labelled water, pedometers, accelerometers, and more (Aparicio-Ugarriza et al., 2014; Ara et al., 2015). PAQs are the most commonly used method in population studies (Esparza-Romero et al., 2015; Gómez, Hernández-Prado, Morales, & Shamah-Levy 2009; Tornos et al., 2009).

The advantage of the PAQs, besides their low cost, is that they can be designed and validated for a given population, including ethnic groups, thus providing information of the specific patterns of physical activity of the population (Kriska et al., 1990; Lavandera-Torres & Esparza-Romero, 2017; Macniven et al., 2016). PAQs can lead to inaccuracies because they depend on the memory of the interviewee (Ara et al., 2015), but strategies can be generated to reduce this disadvantage. One important aspect that should be considered when PAQs are selected to measure PA is their previous adaptation based on the target population to be studied. Applying a PAQ generated from a particular community to a new population with different cultural characteristics can lead to inaccuracies (Arredondo, Mendelson, Holub, Espinoza, & Marshall, 2012). The short version of the International Questionnaire of Physical Activity, which originally had adequate validation and reproducibility for 12 countries, had poor validity and a modest reproducibility for the evaluation of moderate and vigorous PA in the Mexican population (Medina, Barquera, & Janssen, 2013). Although not discussed by the authors (Medina et al., 2013) it is important to consider the adaptation process in selecting PAQs (Moreira et al., 2013; Oyeyemi et al., 2016; Oyeyemi et al., 2011).

Indigenous populations have less favorable health conditions and higher prevalence of obesity and NCD than non-indigenous populations (Gracey & King 2015). This makes the specific study of PA and its association with obesity and NCD in these ethnic minorities relevant. However, it is necessary to generate and evaluate measurement instruments, such as PAQs, according to the context and culture of these populations (Arredondo et al., 2012; Medina et al., 2013).

Some questionnaires have been designed and validated for indigenous populations (Esparza et al., 2010; Kriska et al., 1990; Lavandera-Torres & Esparza-Romero, 2017; Trost, Marshall, Miller, Hurley, & Hunt, 2007). Kriska et al. (1990) developed a PAQ to study PA and its role in type 2 diabetes in U.S. Pima Indians. Similarly Lavandera-Torres & Esparza-Romero (2017), adapted and studied the reproducibility of a PAQ in indigenous Seris of México with good results. Esparza et al. (2010) adapted the questionnaire by Kriska et al. (1990) to investigate the relationship of PA with obesity in Mexican Pima Indians.

The Yaqui Indians are an ethnic group from Sonora, Mexico, originally settled along the Yaqui River, between the municipalities of Cajeme and Guaymas. Its territory includes three areas: mountainous, fishing and farming (Moctezuma-Zamarron, 2007). This indigenous group has presented changes in their lifestyle; for example, their agricultural activity has gone from being self-sufficient to commercial, from manual to mechanized and even to land rent. It is reasonable to speculate that their physical activity has decreased as a result. Furthermore, while studies have reported that the Yaquis present problems of obesity and NCDs (Brito-Zurita et al., 2007; Rodríguez-Morán et al., 2008), no information has been reported about their PA. The purpose of this study was to adapt and evaluate the reproducibility of a PAQ to study PA in adult Yaquis in Sonora, Mexico.

Materials and Method
Participants
The study participants were 100 Yaqui Indians, including men and non-pregnant women aged 20 or over from the following Yaqui Indians communities: Loma de Guamúchil, Loma de Bácum, Tórim, Vícam Pueblo, Vícam Switch, Casas Blancas,

Pótam, Ráhum and Bélem. Participants were selected if they had stable and/or temporary employment or domestic duties. The number of participants were 40 for the adaptation phase of the PAQ and 60 for the evaluation of its reproducibility. Participants were selected proportionally to the adult population of each community using information from the National Institute of Statistics and Geography (INEGI, 2010). The sample size was based in obtaining significant correlation coefficients greater or equal to 0.4, with $\alpha=0.05$ and a power of 90% (Norman & Streiner, 2000). The interviews were completed in the homes of the participants during the period of June through August, 2016.

Description of the Physical Activity Questionnaire
The applied questionnaire was similar to that designed and validated by Kriska et al. (1990) for U.S. Pimas and adapted by Esparza et al. (2000) for the Pima population of Sonora, México. This PAQ evaluates the PA of the previous 12 months and for the previous week. For purposes of this paper, only the previous 12 months were evaluated. The PAQ consists of two sections: the first includes questions about the leisure-time activities and the second about occupational activities. Frequencies such as months per year, weeks per month, days per week and the number of hours per day for each activity were registered to estimate the average number of hours per week (h/wk) for each activity.

Adaptation
For this phase, the methodology proposed by Lavandera-Torres and Esparza-Romero (2017) was carried out for 40 Yaquis Indians. During each interview, the participants were asked to describe in detail their leisure-time, occupational and transportation activities. The information generated was book recorded, considered and included in the PAQ.

To classify the identified activities, they were analyzed in detail and assigned with metabolic equivalents (METs) based on the Compendium of Physical Activity (Ainsworth et al., 2011). Activities were classified as sedentary behaviors (1 to 1.5 METs) and light (1.6 to 2.9 METs), moderate (3 to 5.9 METs) and vigorous ($\geq$6 METs) activities. A MET represent the oxygen rate of approximately 3.5 ml/kg · min for an average adult who is sitting quietly (Ainsworth et al., 2011).

Reproducibility
The reproducibility of the adapted PAQ was evaluated through the test-retest protocol. The PAQ was applied to the Yaquis adult sample twice with a margin between applications of 1 to 3 weeks.

Anthropometric Measurements
Participants were evaluated for weight, height, and waist circumference according to the methodology of the International Society for the Advancement of Cineanthropometry (ISAK, 2001).

Statistical Analysis
The PA (h/wk) was analyzed as total, light, moderate and vigorous leisure-time and occupational activities and as sedentary behaviors (i.e., watching television and talking/sitting at home with family and neighbors [socializing]). Furthermore, PA was additionally analyzed as specific domains such as sports (soccer, baseball and softball), craftwork (embroidery and making reed curtains), agricultural (sowing by hand, harvesting, and fumigating) and housework (sweeping, mopping, washing clothes by hand, and preparing food).

To evaluate the reproducibility of the adapted PAQ, PA information of the applied PAQs (PAQ1 at starting time and PAQ2 after 1-3 weeks apart) from the previous 12 months was analyzed using the Spearman Correlation Coefficient (ρ) and the two-way mixed model (average measure) Intraclass Correlation Coefficient (ICC). The degree of relations for ρ were defined as weak (ρ between 0.11-0.25), half (ρ between 0.26-0.50), considerable (ρ between 0.51-0.75) and very strong (ρ between 0.76-0.90) (Hernández& Fernandez, 2010). The ICC ratings suggested by Landis and Koch were used to evaluate the degree of relation of the PAQs (reproducibility) as poor (0-0.2), fair (0.2-0.4), moderate (0.4-0.6) substantial (0.6-0.8) and almost perfect (0.8-1.0) (Landis & Koch, 1997).

Bland-Altman plots were used to determine the level agreement between the PAQ1 and PAQ2 regarding total leisure-time, occupational activities and sedentary behaviors (h/wk). In other words, Bland-Altman plots provided information about the magnitude of overestimation (mean bias above the

zero line) or underestimation (mean bias below the zero line) of the PAQ1 with respect to PAQ2; in either case, mean bias was analyzed by the paired t-test. Simple linear regression was performed to evaluate homogeneity of the differences (bias) over the range of average values (h/wk) from the two PAQs measurements. The dependent variables were the differences (h/wk) between PAQ1 and PAQ2, and the independent variables were the average (h/wk) of both PAQs. Biases falling outside the Bland-Altman agreement interval were expressed as percentage.

Stata software version 14 was used for the statistical analysis (Stata Corp LP, College Station, Texas, USA; URL: http://www.stata.com). Significance was considered at a p-value of $p \leq 0.05$.

Ethics approval
The protocol was approved by the Ethics Committee of the Research Center for Food and Development. Before the interview, each participant received complete information about the project and signed a consent form.

Results
Participants
Initially, there were 66 participants for the study of reproducibility, but only 60 completed the second PAQ (15 men and 45 women). Ages ranged from 20 to 65 years, with an average of 40.0 years for men and 37.8 years for women. Anthropometric characteristics such as weight, height, body mass index and waist circumference are shown in Table 1.

Table 1. Anthropometric characteristics of the participants

	Men (n=17)		Women (n=43)	
	Mean ± SD	Range	Mean ± SD	Range
Age (year)	40.8 ± 14.4	20 - 65	37.8 ± 26.8	20 - 65
Weight (kg)	73.2 ± 7.3	55.1 - 99.5	73.4 ± 1.3	39.7 - 119.1
Height (cm)	170.6 ± 0.03	1.6 - 1.8	156.7 ± 0.03	1.4 - 1.7
BMI (kg/m2)	25.1 ± 3.6	18 - 32.4	29.8 ± 0.7	19.2 - 44
Waist circumference (cm)	89.6 ± 2.1	70 - 107	94 ± 3.5	68.5 - 115

Date are shown as the mean, standar deviation and range

Adaptation
Eighteen leisure-time activities were recorded, including sports and exercise related activities such as football, baseball, softball, jogging, and walking as well as sedentary behaviors such as watching television and socializing. Thirty-four occupational activities were reported and related to agriculture, silviculture, construction, craftwork, among others; each of the occupational activities consisted of a series of sub-activities. Housework activities consisted of sweeping, mopping, handwashing, hauling water, making flour tortillas and others. Activities related to transport included walking, biking, and riding horses or traveling in cars or trucks. Table 2 shows a larger number of activities reported by the Yaquis Indians along with the values of METs assigned to them. These activities were listed in the PAQ. In addition, an open question was added at the end of the list to further include activities that interviewees considered as being part of their PA pattern.

Table 2. List of leisure-time, occupational, and transportation activities

Activities (METs[a])			
Leisure-time		Occupational	Transportation
Sports	**Agricultural**	Craftwork	Walking (3)
Soccer (7)	Sowing by hand (4.3)	Embroidery (1.8)	Bicycle (4)
Baseball (5)	Cutting herb (6.3)	Sewing (1.8)	Horse (3.8)
Softball (5)	Fumigating (4.5)	Making reed curtains (2.5)	Car (2.5)
Basketball (6.5)	Harvesting (4.8)	Making brooms (3)	Bus (1.3)
Exercise	**Cattle raising**	**Housework**	Truck (2.5)
Zumba (5)	Order (3.5)	Sweeping (2.3)	
Weight training (6)	Making cheese (3)	Washing clothes by hand (2)	
Bicycling (4)	Shepherding (3.8)	Carrying water (4.5)	
Jogging (4.5)	**Silviculture**	Watering plants (2)	
Run (6)	Cutting firewood (6.3)	Making flour tortillas (2)	
Walking (3.5)	Make coal (6.3)	Cooking in a hornilla[c] (2)	
Sedentary behavior	**Construction**	Washing dishes (1.8)	
Socializing[b] (1.5)	Making bricks (6.5)	**Other:**	
Watching television (1.3)	Plaster (6.3)	Baking (2)	
	Pasting Block (4.5)	Playing music (2)	
	Laying tile (3.8)	Teaching (1.8)	
	Cement (6.5)	Maquiladora operator (3.3)	

[a] METs: Metabolic Equivalents
[b] Talking/sitting at home with family and neighbors
[c] Hornilla: Hollow where embers or firewood are placed, with a side vent and a top grille.

Reproducibility
The results of the test-retest analysis regarding leisure-time and occupational activities are shown in Table 3. The ρ values of moderate, vigorous and total leisure-time (h/week) indicate a very strong correlation between PAQ1 and PAQ2 (ρ=0.94 and ρ =0.91, ρ=0.92, respectively; p<0.00001). The ICC revealed almost perfect correlations for total leisure-time activities and categories of intensity. The results of ρ for occupational activities indicated a very strong correlation between PAQ1 and PAQ2 for light, moderate, vigorous and total occupational activities (ρ=0.87, ρ=0.84, ρ=0.91, ρ=0.88, respectively; p<0.00001). For the ICC, all the values showed almost perfect correlation for occupational activities.

Table 3. Reliability for leisure-time and occupational activities, specific domains of activities and sedentary behaviors between PAQ[a]1 and PAQ[a]2

	ρ[c]*	ICC[d] **
Leisure-time Activities (h/wk[b])		
Moderate	0.94	0.97
Vigorous	0.91	0.98
Total	0.92	0.95
Occupational Activities (h/wk[b])		
Light	0.87	0.95
Moderate	0.84	0.95
Vigorous	0.91	0.98
Total	0.88	0.94
Specific domains of activities (h/wk[b])		
Sports	0.99	0.99
Craftwork	0.93	0.99
Agricultural	0.99	0.99
Housework	0.91	0.96
Sedentary behaviors (h/wk[b])		
Watching television	0.89	0.99
Socializing[e]	0.82	0.91
Total	0.94	0.96

[a] Physical Activity Questionnaire
[b] Hours per week
[c] Spearman rank correlation coefficient. *$p < 0.00001$
[d] Intraclass correlation coefficient. **$p < 0.0001$
[e] Talking/sitting at home with family and neighbors

The specific domains of activities such as sports, craftwork, agriculture and housework yielded ρ values greater than 0.90 (p<0.00001), indicating very strong correlations. Regarding ICC values, all the correlations of the specific domains of activities were cataloged as almost perfect (Table 3).

With regard to total sedentary behaviors, the ρ value (ρ=0.94; p<0.00001) indicated a very strong correlation. The correlations for watching television and socializing at home were also considered very strong. The ICC values for all sedentary behaviors indicated almost perfect correlations (Table 3).

The Bland-Altman plot (Figure 1) shows mean bias, the regression line and the limits of agreement for total leisure-time activities (h/wk). The mean bias was not different from zero (mean bias=0.72, p>0.05). In the same plot, the regression line indicated that differences between measurements (β = 0.041, p=0.77) were homogeneously distributed throughout the average (h/wk) of total leisure activities. The limits of agreement (LOA) were -

10.11 (lower LOA) to 8.66 (upper LOA) with 10% of bias outside of LOA.
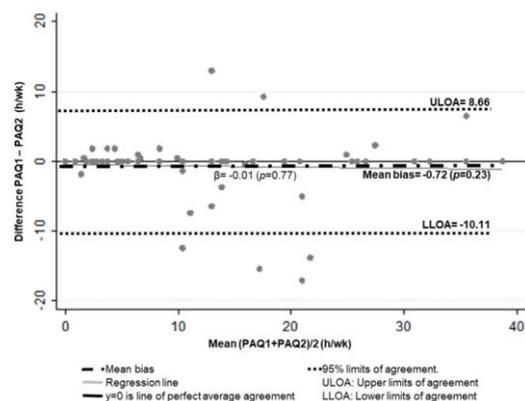
Figure 1: Bland-Altman plot for total leisure-time activities (h/wk) as assessed by the PAQ1 and PAQ2

Regarding total occupational activities, the Bland-Altman plot (Figure 2) revealed that mean bias was also similar to zero (mean bias=-0.39, p=0.76). Further, the plot also shows that differences were homogeneous among the average values in h/wk of total occupational activities (β=0.87, p=0.16). The LOA were 21.3 (lower LOA) to 20.5 (upper LOA), with 5% of the bias outside of LOA.
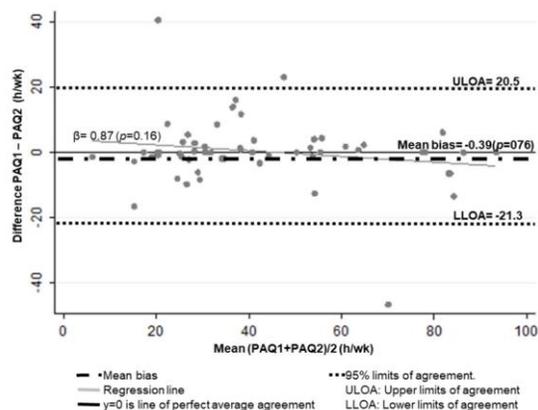
Figure 2: Bland-Altman plot for total occupational activities (h/wk) as assessed by the PAQ1 and PAQ2

Discussion
The adaptation phase allowed for a detailed identification of common leisure-time, occupational and transportation activities among the Yaqui Indians to investigate how activities were performed.

The leisure-time activities mainly included watching television, socializing (sedentary behaviors) and some sports activities. The activity of socializing is facilitated because Yaqui households consist of a large, fenced-in land in which different generations of the same family live together (grandparents, parents and offspring). During the afternoon and mid-morning, Yaqui family members typically chat in their homes under the shade of trees or ramadas (a roof, without walls, built with mesquite sticks, reed and other plants). On the other hand, occupational activities were related to agriculture, construction, silviculture, craftwork activities and housework, among others.

The adaptation phase allowed for uncovering the types of PA that adult Yaquis perform in their daily lives as well as how they are carried out. This latter information was useful to further classify sedentary behaviors light, moderate, and vigorous PA. This phase also permitted the identification of the appropriate terms used for the different PAs, which was useful for reducing misunderstandings during the interview and thus improving the accuracy of the PAQ.

Regarding reproducibility, the correlation values obtained for total leisure-time and occupational activities in the previous 12 months were similar to those reported by Kriska et al. (1990) in U.S. Pima Indians 21 to 36 years of age ($\rho=0.92$ y $\rho=0.88$, respectively, $p<0.05$). These correlation values were higher than those reported by Lavandera-Torres and Esparza-Romero (2017) for the Seri population with values of $\rho=0.82$ ($p<0.05$) for total leisure activities and values of $\rho=0.58$ ($p<0.05$) for total occupational activities. The correlation values obtained for both activities were also higher than those obtained by Sobngwi, Mbanya, Unwin, Aspray, & Alberti (2001) in a rural population of Cameroon.

It should be noted that in the present study, leisure-time and occupational activities were subcategorized and analyzed by light, moderate and vigorous intensity. However, in the literature, ρ and ICC values are shown for moderate and vigorous total activities without classifying them as leisure-time or occupational activities (Vasheghani-Farahani, et al., 2011; Cust et al., 2008). Such is the case for the study

reported by Medina, et al. (2013) in a Mexican population where reproducibility of the International Physical Activity Questionnaire was evaluated. In that study, ICC values for moderate and vigorous activities were 0.49 and 0.50 ($p<0.05$), respectively, which are lower than those obtained in the present work. In a different study conducted among a Nigerian population, ICC values reported for moderate and vigorous activities were also lower than those obtained in this study (ICC=0.73 and 0.33, respectively) (Oyeyemi et al., 2011)

When activities were analyzed as specific domains, high correlation values between the two PAQs in the previous 12 months were observed in all the specific domains (sports, craftwork, agricultural and housework). The values for sports activities found here were higher than those reported in other studies (Lavandera-Torres and Esparza-Romero, 2017). The correlation found for the housework activities was higher than that reported by Cust et al. (2008) ($\rho=0.73$; $p<0.0001$) and other studies (Vasheghani et al., 2011; Chu & Moy, 2015). Finally, the correlation evaluated by ρ for the group of craftwork activities was slightly lower than that reported by Lavandera-Torres and Esparza-Romero ($\rho=0.97$; $p<0.05$) (2017).

The reproducibility of sitting time as a marker of sedentary behaviors was evaluated in different studies using the International Physical Activity Questionnaire (Chu & Moy, 2015; Oyeyemi et al., 2011; Vasheghani et al., 2011). The results of these studies were ICC=0.84, ICC=0.73 and ICC=0.56, for Malaysia, Iranian and Nigerian populations, respectively (Chu & Moy, 2015; Oyeyemi et al., 2011; Vasheghani et al., 2011). Sedentary behaviors in this study had higher correlation values.

The Bland-Altman plots showed that PA measured by PAQ1 was similar to that measured by PAQ2. That mean bias was close to zero indicates agreement between both questionnaires. In addition, linear regression analysis showed that the error or differences between PAQs were constant over the range of h/wk of physical activity.

The results of the reproducibility of this study are largely explained by the adaptation process because it allowed for the use of specific terms for the

different activities in the community and for the idea of listing them in the questionnaire format. This means that interviewees were able to better understand the questions, and the interviewer could be clear about the meaning of the questions. Another important aspect of this study was the previous training received by the interviewers, part of which consisted of understanding the community and conducting previous PAQs with people of the community.

Conclusions

The adaptation phase allowed for a detailed identification of the most important leisure-time, occupational and transportation activities among the Yaqui Indians to investigate how these activities were performed and to determine the appropriate terms to use for the PAQs. The adapted PAQ had high reproducibility for measuring PA during the previous 12 months, and it may therefore be used to evaluate PA and its association with obesity and NCD in the Yaqui Indian population.

Acknowledgments

References

Ainsworth, B. E., Haskell, W. L., Herrmann, S. D., Meckes, N., Bassett Jr, D. R., Tudor-Locke, C., Greer, J., L., Veznia, J., Whitt-Glover M.C. & Leon, A. S. (2011). 2011 Compendium of Physical Activities: a second update of codes and MET values. *Medicine & science in sports & exercise, 43*(8), 1575-1581.

Aparicio-Ugarriza, R., Mielgo-Ayuso, J., Benito, P. J., Pedrero-Chamizo, R., Ara, I., González-Gross, M. & EXERNET Study Group. (2015). Physical activity assessment in the general population; instrumental methods and new technologies. *Nutrición Hospitalaira, 31*(3).

Ara, I., Aparicio-Ugarriza, R., Morales-Barco, D., de Souza, W. N., Mata, E. & González-Gross, M. (2015). Physical activity assessment in the general population; validated self-report methods. *Nutrición Hospitalaria, 31*(3).

Arredondo, E., M., Mendelson, T., Holub, C., Espinoza, N. & Marshall, S. (2012). Cultural adaptation of physical activity self-report instruments. *Journal of Physical Activity and Health, 9*(s1), S37-S43.

Brito-Zurita, O., Dominguez-Banda, A., Ugalde-Aguirre, V., Cortez-Valenzuela, A., Villanueva-Perez, R., Rodríguez-Morán, M. & Guerrero-Romero, F. (2007). Distribution of abdominal adiposity and cardiovascular risk factors in yaquis indians from sonora, México. *Metabolic syndrome and related disorders, 5*(4), 353-358.

Chu, A. H. Y. & Moy, F. M. (2015). Reliability and validity of the Malay International Physical Activity Questionnaire (IPAQ-M) among a Malay population in Malaysia. *Asian Pacific Journal Public Health, 27*(2), NP2381-NP2389.

Cust, A. E., Smith, B. J., Chau, J., van der Ploeg, H. P., Friedenreich, C. M., Armstrong, B. K. & Bauman, A. (2008). Validity and repeatability of the EPIC physical activity questionnaire: a validation study using accelerometers as an objective measure. *International Journal of Behavioral Nutrition and Physical Activity, 5*(1), 33.

Esparza, J., Fox, C., Harper, I. T., Bennett, P. H., Schulz, L. O., Valencia, M. E. & Ravussin, E. (2000). Daily energy expenditure in Mexican and USA Pima Indians: low physical activity as a possible cause of obesity. *International Journal of Obesity, 24*(1), 55.

Esparza-Romero, J., Valencia, M. E., Urquidez-Romero, R., Chaudhari, L. S., Hanson, R. L., Knowler, W. C., Ravissin, E., Bennett, P. & Schulz, L. O. (2015). Environmentally driven increases in type 2 diabetes and obesity in Pima Indians and non-Pimas in Mexico over a 15-year period: the Maycoba Project. *Diabetes Care, 38*(11), 2075-2082.

Foulds, H. J., Bredin, S. S., Charlesworth, S. A., Ivey, A. C. & Warburton, D. E. (2014). Exercise volume and intensity: a dose–response relationship with health benefits. *European Journal of Applied Physiology, 114*(8), 1563-1571.

Golubic, R., Wijndaele, K., Sharp, S. J., Simmons, R. K., Griffin, S. J., Wareham, N. J., Ekelund, U., Brage, S. (2015). Physical activity, sedentary time and gain in overall and central body fat: 7-year follow-up of the ProActive trial cohort. *International Journal of Obesity, 39*(1), 142.

Gómez, L., M. Hernández-Prado, B., Morales, M. D. C. & Shamah-Levy, T. (2009). Physical activity and overweight/obesity in adult Mexican population: the Mexican National Health and Nutrition Survey 2006. *Salud Pública de México, 51*, S621-S629.

Gracey, M., & King, M. (2009). Indigenous health part 1: determinants and disease patterns. *The Lancet, 374*(9683), 65-75.

Hallal, P. C., Andersen, L. B., Bull, F. C., Guthold, R., Haskell, W., Ekelund, U. & Lancet Physical Activity Series Working Group. (2012). Global physical activity levels: surveillance progress, pitfalls, and prospects. *The Lancet, 380*(9838), 247-257.

Hernández R. & Fernández C (2010). *Metodología de la Investigación.* Perú: McGraw Hill.

Instituto Nacional de Estadística y Geografía (2010). *Censo Nacional de Población y Vivienda 2010*. Recovered form: http://www.inegi.org.mx/geo/contenidos/mapadigital (09/16/2016).

Jakicic, J. M., Tate, D. F., Lang, W., Davis, K. K., Polzien, K., Neiberg, R. H., Rickman, A. & Erickson, K. (2014). Objective physical activity and weight loss in adults: The step-up randomized clinical trial. *Obesity, 22*(11), 2284-2292.

Janssen, I. & LeBlanc, A. G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity, 7*(1), 40.

Kriska, A. M., Knowler, W. C., LaPorte, R. E., Drash, A. L., Wing, R. R., Blair, S. N., Bennett, P. & Kuller, L. H. (1990). Development of questionnaire to examine relationship of physical activity and diabetes in Pima Indians. *Diabetes Care, 13*(4), 401-411.

Landis, J. R. & Koch, G. G. (1977). *The measurement of observer agreement for categorical data.* Biometrics, 159-174.

Lavandera-Torres, M. & Esparza-Romero, J. (2017). Adaptation and reproducibility of a questionnaire to evaluate physical activity among the Comcáac (Seri) community of Sonora, México. *Acta Universitaria, 27*(1), 76-82.

Lee, I. M., Shiroma, E. J., Lobelo, F., Puska, P., Blair, S. N., Katzmarzyk, P. T. & Lancet Physical Activity Series Working Group. (2012). Effect of physical inactivity on major non-communicable diseases

worldwide: an analysis of burden of disease and life expectancy. *The Lancet, 380*(9838), 219-229.

Macniven, R., Richards, J., Gubhaju, L., Joshy, G., Bauman, A., Banks, E. & Eades, S. (2016). Physical activity, healthy lifestyle behaviors, neighborhood environment characteristics and social support among Australian Aboriginal and non-Aboriginal adults. *Preventive Medicine Reports, 3*, 203-210.

Maher, C. A., Mire, E., Harrington, D. M., Staiano, A. E. & Katzmarzyk, P. T. (2013). The independent and combined associations of physical activity and sedentary behavior with obesity in adults: NHANES 2003-06. *Obesity, 21*(12).

Medina, C., Barquera, S. & Janssen, I. (2013). Validity and reliability of the International Physical Activity Questionnaire among adults in México. *Revista Panamericana de Salud Pública, 34*, 21-28.

Mekary, R. A., Grøntved, A., Despres, J. P., De Moura, L. P., Asgarzadeh, M., Willett, W. C., Rimm, E.B., Giovannucci, E & Hu, F. B. (2015). Weight training, aerobic physical activities, and long-term waist circumference change in men. *Obesity, 23*(2), 461-467.

Moctezuma-Zamarron, J. L. (2007). *Yaquis, Pueblos Indígenas del México Contemporáneo*. CDI, México. Recovered from: https://www.gob.mx/cms/uploads/attachment/file/12597/yaquis.pdf 29 (09/16/2016)

Moreira, T., Matheus, R., Bueno, M., Miura, C., Domingues, G & Godin, G. (2013). Cultural adaptation of the Brazilian version of the Godin-Shephard Leisure-Time Physical Activity Questionnaire. *Rev Saude Publica, 47*(3),479-487.

Norman G. & Streiner D. (2000). *Biostatistics.* The bare essentials. Ontario: BC Decker.

Oyeyemi, A. L., Oyeyemi, A. Y., Adegoke, B. O., Oyetoke, F. O., Aliyu, H. N., Aliyu, S. U. & Rufai, A. A. (2011). The Short International Physical Activity Questionnaire: cross-cultural adaptation, validation and reliability of the Hausa language version in Nigeria. *BMC Medical Research Methodology, 11*(1), 156.

Oyeyemi, A., L., Kasoma, S., S., Onywera, V., O., Assah, F., Adedoyin, R., A., Conway, T., L. & Prista, A. (2016) NEWS for Africa: adaptation and reliability of a built environment questionnaire for physical activity in seven African countries. *International Journal of Behavioral Nutrition and Physical Activity, 8*(1), 13-33.

Rodríguez-Morán, M., Guerrero-Romero, F., Brito-Zurita, O., Rascón-Pacheco, R. A., Pérez-Fuentes, R., Sánchez-Guillén, M. C., Gonzáles-Ortiz M., Martínez-Abundis E., Simental-Mendía L., Madero A., Revilla-Monsalve, C., Flores-Martínez, S., Islas-Andrade, S, Cruz, M. & Sánchez-Corona J. (2008). Cardiovascular risk factors and acculturation in Yaquis and Tepehuanos Indians from Mexico. *Medical Research Archive, 39*(3), 352-357.

Sallis, J. F., Bull, F., Guthold, R., Heath, G. W., Inoue, S., Kelly, P., Oyeyemi. A., Pérez, L., Richards, J., Hallal, P. & Lancet Physical Activity Series 2 Executive Committee. (2016). Progress in physical activity over the Olympic quadrennium. *The Lancet, 388*(10051), 1325-1336.

Sobngwi, E., Mbanya, J. C. N., Unwin, N. C., Aspray, T. J. & Alberti, K. G. M. M. (2001). Development and validation of a questionnaire for the assessment of physical activity in epidemiological studies in Sub-Saharan Africa. *International Journal of Epidemiol, 30*(6), 1361-1368.

Sociedad Internacional para el Avance de la Kineantropmetría (ISAK) (2001). *Estándares internacionales para la valoración antropométrica.* Australia: Sociedad Internacional para el Avance de la Kineantropmetría.

Tornos, I. S., Iribas, C. M., Rueda, J. J. V., Uche, A. M. G., Goñi, C. A. & Martínez, M. S. (2009). Estudio poblacional de actividad física en tiempo libre. *Gac Sanit, 23*(2), 127-132.

Trost, S. G., Marshall, A. L., Miller, R., Hurley, J. T. & Hunt, J. A. (2007). Validation of a 24-h physical activity recall in indigenous and non-indigenous Australian adolescents. *Journal Science Medical Sport, 10*(6), 428-435.

Vasheghani-Farahani, A., Tahmasbi, M., Asheri, H., Ashraf, H., Nedjat, S. & Kordi, R. (2011). The Persian, last 7-day, long form of the International Physical Activity Questionnaire: translation and validation study. *Asian Journal Sports Medicine, 2*(2), 106.

Wanner, M., Martin, B. W., Autenrieth, C. S., Schaffner, E., Meier, F., Brombach, C., Stolz, D., Bauman, A., Rochat. T., Schindler, C. & Kriemler, S. (2016). Associations between domains of physical activity, sitting time, and different measures of overweight and obesity. *Preventive Medicine Report, 3*, 177-184.

World Health Organizations (2010). *Global recommendations on physical activity for health.* Recovered from: http://www.who.int/dietphysicalactivity/factsheet_recommendations/en/ (09/16/2016).