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Validation of a Pictorial Survey Tool to Measure Time Use in an African Urban Setting

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Abstract

Background: Disease often depends on how a host interacts with his or her environment. This interaction is important for respiratory infectious diseases, where built environments may promote transmission. To learn about time use, or the amount of time people spend in a day doing various activities,

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in sub-Saharan Africa may be difficult because of low literacy and different cultural perceptions of time. We developed a culturally appropriate survey tool to measure time use called the mweso game. **Method:** Three cross-sectional studies were performed among adults in Kampala, Uganda, to evaluate criterion and construct validity and to assess reliability of the mweso game. The mweso game was compared to actual elapsed time, a detailed 24-hr recall survey, and between three different recall periods. In all analyses, the mean number of beads, or hours, was calculated; Pearson correlation coefficients and Cronbach's α were estimated. **Results:** Criterion validity for the use of beads to measure time was fair; mean values tended to be accurate, but there was variability in estimates of time across participants. When comparing the mweso game to the 24-hr recall survey, construct validity was very good. For most of the settings, the difference between measurements was less than one hour; there was good to excellent correlation for most settings. Reliability and internal consistency were best for time use at home and work. **Conclusions:** We have developed the mweso game as an instrument to measure time use in the context of low literacy and different cultural perceptions of time. The mweso game was valid and reliable, especially for measuring time use at home and work. With further validation, it may prove useful in measuring time use and in studying its relation to transmission of respiratory infectious diseases.

Keywords

time use survey, pictorial tool, social networks, Urban Africa, validity, reliabilty

Disease often depends on how a host interacts with his or her environment. This interaction is especially important for respiratory infectious diseases where transmission occurs within built environments that permit the mixing of infectious cases with susceptible contacts. Using tuberculosis as an example, there is growing interest in developing ways to map where in a community, and in what settings, transmission of *Mycobacterium tuberculosis* is likely to occur by tracing the movements of infectious cases (Andrews et al. 2015). If we had a better understanding of the setting and location of transmission events, we would be able to design more intelligent, community-oriented interventions built around social settings or geographic locations, instead of through public clinics. Yet little is known about the mixing patterns of infectious tuberculosis cases and their contacts, in part, because the

tools for measuring time use, or the amount of time people spend in a day doing various activities, are limited, especially in low-income countries.

Commonly used methods to measure time use include direct observation, diaries, and self-reported recall (Masuda et al. 2014). Self-reported recall surveys are the most convenient and widely used (Fink, Weeks, and Hill 2012; Polack et al. 2010). These methods may be inaccurate, however, in cultures where time is not measured using clocks or watches (Grosh and Glewwe 2000; Kes and Swaminathan 2006), but instead where time is assessed by the recollection of key life events of cyclical patterns, such as the position of the sun in the sky or seasonal harvesting season. To understand how people allocate their time during the day and where they spend their time, we need accurate and reliable tools to measure time use (Kahneman et al. 2004).

To assess time use in various social settings in Kampala, Uganda, we developed a pictorial survey that adapts a familiar local board game, called mweso or mancala, which uses the strategic placement of beads on the board to win the game. We adapted this game as a way to measure time use accurately and reliably in a population where the national literacy is about 80% and where many people often do not rely on watches to tell time. The game included a board with a representative set of photographs from familiar social settings where residents of Kampala may spend their time, such as home, work, school, church, or market place. Each study participant was given 24 beads to represent the hours in the day and was asked to place the beads on the board in proportion to the time spent in each social setting. In the present analysis, we validated this time use instrument, referred to as the mweso game.

Method

We performed three cross-sectional studies specifically designed to evaluate the validity and reliability of the mweso game as a time use measurement tool in an African urban setting. In one study of 60 participants, we established criterion validity by comparing the responses of the mweso game to actual elapsed time. In a second study of 50 different participants, we established construct validity by comparing the responses of the mweso game to a validated time use 24-hr recall questionnaire. In the third study, we evaluated reliability of the mweso game in 568 individuals by comparing participants' responses for three recall periods: the previous day, the typical weekday, and the typical weekend day.

Mweso Game

The mweso game was administered to study participants in a standard way by experienced interviewers who were trained on how to prompt for responses and assist participants in completing the game. During an encounter, an interviewer instructed the participant on how to play the game. The interviewer gave the participant 24 beads and explained that each bead represented one hour of a 24-hr day. The interviewer then oriented the participant to a board with representative photographs of various social settings where the participant may spend time. These settings included home, work, school, worship setting, market place, hair salon, gym, club, bar, kiosk, hospital, women's group, and taxi/transportation.

After this orientation, the interviewer instructed the participant to put the beads on the photographs that best represented the settings where they spent their time. Participants were asked to put down beads in proportion to the amount of time in hours spent at each setting, until all 24 beads were allocated, thereby ending this round of the game. After the participant placed all beads on the board, the interviewer recorded the number of beads placed on all settings. The mweso game ran for three rounds: the first recorded time spent in various settings during the previous day (yesterday), the second recorded time spent in settings during a typical weekday, and the third recorded time spent in various settings during the last weekend day. Each round would take about 5 min to complete.

Criterion Validity

In this cross-sectional study, we assessed the local perception of time in a convenience sample of 60 men and women (15 years or older) who were interviewed while waiting to visit the doctor or pick up medication at Kitebi clinic in Kampala, Uganda. Participants were approached twice, first to consent to the interview, and a second time between 30 minutes and three hours later to complete the interview. The actual time the participant was approached to consent and the time the interview started were documented. As part of the interview, participants were given the 24 beads and were told that each bead represented one hour. Using these beads, participants were asked to estimate the number of hours they perceived waiting in the clinic since a field worker first approached them to consent to the interview. In addition, the participants used the beads to estimate the number of hours the sun is in the sky, the number of hours that had passed since 7 a.m. that morning (sunrise), and the number of hours that had passed since 7 p.m. the

day before (sunset). The actual number of hours passed waiting in the clinic and number of hours passed since these times of day were calculated and recorded. Gender, age, education, possession of a watch or cell phone, and the method in which participants tell time (cell phone, sun, clock, radio, watch, and other) were also documented.

Construct Validity

We assessed the construct validity of the mweso game by comparing the responses to the mweso game with a standardized, detailed 24-hr recall questionnaire (Kes and Swaminathan 2006). The standard 24-hr questionnaire was performed in a random sample of 50 individuals who were enrolled in a cohort study about the incidence of tuberculosis infection from March through November 2015. This cohort study recruited adult residents (age 18–65 years) of Lubaga Division, Kampala, Uganda, from a community-based survey of tuberculosis infection performed in community locations and not health clinics. Residents were eligible for the study if the tuberculin skin test was less than 5 mm. The 24-hr questionnaire consisted of the interviewer asking participants to recall their previous day in 15-min increments starting from 7 a.m. for 24 hr. Interviewers prompted participants for missing time, modes and purpose of transportation, eating, and other necessary details. Settings for each activity were noted on the questionnaire. Trained field staff interviewed these 50 participants within three days of completing the mweso game. In this way, we were able to compare the findings of the mweso game with the standardized 24-hr recall questionnaire.

Internal Reliability

In a convenience sample of 568 participants enrolled in the same cohort study of tuberculosis infection as for the construct validity, we performed a baseline interview using the mweso game. In this interview, we used the mweso game to collect information about how a participant spent his or her time in the previous weekday and during a typical weekday. To establish the internal reliability of the instrument, we compared time use reported for each setting from two different recall periods—previous weekday and typical weekday. This analysis builds on the assumption that responses about time use in a particular setting will correspond to the two different recall periods. This analysis stands in contrast to the analysis of construct validity where we compared time use of the mweso game with the 24-hr questionnaire.

The project was approved by the institutional review boards at the University of Georgia, the Makerere University higher degrees' research and ethics committee, and the Fred Hutchinson Cancer Research Center. All the participants provided consent, either oral or written. They received a transport reimbursement for participating in the study. Questionnaires were administered by trained fieldworkers in the participant's local language (Luganda) or English.

Statistical Analysis

Criterion and Construct Validity

To assess the criterion validity of using beads to measure perceived time, we compared the number of beads measuring perceived time-lapsed to actual time elapsed. To assess construct validity, we compared the number of beads for each setting as reported in the mweso game for the previous day and typical weekday with the estimated time (hours) spent in each setting as measured by the 24-hr recall questionnaire. The mean difference and Pearson correlation coefficient were estimated for all comparisons.

Internal Reliability

Using the baseline responses for the 568 participants, we compared the mweso game responses for the typical weekday to the previous weekday. We estimated the mean of differences in estimated mean hours in each setting (95% confidence intervals), Pearson correlation coefficients (ρ), and Cronbach's α. Statistical analyses were conducted using STATA 13 (Stata Corp., College Station, TX) and SAS 9.4 (SAS Institute Carey, NC).

Results

Criterion Validity

In this validation study, 60 participants completed a questionnaire comparing perceived and actual elapsed time (Table 1). The mean age of participants was 30.6 ($SD = 11.1$, interquartile range [IQR] = 13.5) years, 47 (78.3%) were female and 55 (92%) had completed primary or secondary education. Most participants (45; 75%) owned a cell phone, and 30 (50%) participants used their cell phones to tell time; of the other methods to tell time, 14 (23.3%) used the sun, 10 (16%) used a clock or watch, and 5 (8%) used a radio.

Table 1. Summary of Basic Characteristics of Each Study Group.

Characteristic	Criterion Validity	Construct Validity	Internal Reliability
Number of participants	60	50	568
Mean age, years	30.6	28.6	25.6
Standard deviation	11.1	8.5	6.8
Interquartile range	13.5	14	8
Female—*n* (%)	47 (78.3)	24 (48)	300 (43.5)
Primary or secondary schooling[a]—*n* (%)	55 (92)	35 (70)	550 (96)
No schooling	—	—	18
Primary education	—	—	201
Secondary education or above	—	—	349

[a]Numbers include participants with partial completion of schooling at each level.

Using the beads, participants were able to account for the number of hours the sun is in the sky (Table 2). They overestimated the time spent waiting at the health center by one hour. They estimated time since sunrise (7 a.m.) with the beads to within one hour, with little variation; when estimating time since previous sunset (7 p.m. previous day), the mean was accurate but there was substantial variability with the use of the beads ($SD = 3.39$). Except for the assessment of daylight, the correlation coefficients between the actual time and perceived time were all below 0.6, suggesting moderate to low correlations for each measure.

Construct Validity

In this analysis of validity, 50 participants completed both the mweso game and the detailed 24-hr recall questionnaire (Table 1). The mean age of participants was 28.6 years ($SD = 8.5$, IQR = 14), 24 (48%) were female, and 35 (70%) had completed primary or secondary education. According to the 24-hr recall questionnaire, participants spent most of their time at home (15.8 hr; Table 2) or at work (5.3 hr); for the remainder of the settings, participants spent less than one hour. Overall, there was good to excellent agreement between the 24-hr recall questionnaire and the mweso game previous day assessment; for each setting, the difference was less than one hour (Table 3) and the Pearson correlation coefficients showed good to excellent correlation for many settings (Table 4). The mean of differences for time at home, visiting friends or relatives, or spending time at a bar, gym, or market were

Table 2. Summary of Number of Beads Used to Assess Actual Time in 60 Volunteers.

	Mweso Game Beads			Actual Time			Beads Versus Actual Time (Difference)	
Time Period	*n*	Mean Hours	*SD*	*n*	Mean Hours	*SD*	Mean Hours	ρ
Sun in the sky (hours of sunlight	60	11.65	1.55	60	12	0.00	−0.35	1.00
Waiting time	55	2.31	1.25	58	1.29	0.78	1.05	0.45
7 a.m. today (sunrise)	59	5.15	1.35	58	4.36	0.85	0.82	0.59
7 p.m. yesterday (sunset)	58	16.62	3.39	58	16.36	0.85	0.27	0.23

Note. *SD* = standard deviation; ρ = Pearson correlation coefficient.

all less than zero, indicating a greater amount of time assessed by the mweso game. When comparing the 24-hr recall questionnaire with the mweso game assessment of the typical weekday, participants overestimated the time at work by one hour; other assessments were similar between the two questionnaires (Tables 3 and 4).

In another test of construct validity, we compared the concordance in responses between the 24-hr recall questionnaire and the mweso previous day assessment according to level of education classified a primary education or none versus secondary education or greater. For nearly all of the settings, the κ values were similar between the groups (Supplemental Material Table S2: http://smr.sagepub.com/supplemental/).

Internal Reliability

To evaluate the internal validity of the mweso game, we compared the baseline responses to the mweso game from 568 participants. The mean age of these participants was 25.6 years ($SD = 6.8$, IQR = 8), 300 (43.5%) were female, and 550 (92%) had some level of primary ($N = 201$, 35%) or secondary education ($N = 349$, 61%). In comparing time use during the previous weekday to the typical weekday, most participants spent about 12–13 hr at home; the mean of difference between assessments was 0.45 hr, and the responses were highly correlated ($\rho = 0.74$; Table 5). Moreover, there is evidence for an acceptable internal consistency between these two assessments of time use (Cronbach's $\alpha = .70$). Participants spent about 9 hr per day

Table 3. Mean Number of Hours Spent in Different Time Use Settings among 50 Respondents Who Completed the 24-hr Recall Survey and the Mweso Game Instrument, Including Mweso Previous Day and Mweso Typical Weekday.

	24-Hour Recall Survey		Mweso Previous Day		Mweso Typical Weekday	
Setting	*n*	Mean Hours (*SD*)	*n*	Mean Hours (*SD*)	*n*	Mean Hours (*SD*)
Home	50	15.79 (4.91)	50	16.14 (5.57)	50	15.16 (5.09)
Relative's home	5	0.32 (1.29)	8	0.54 (1.67)	7	0.48 (1.63)
Friend's home	10	0.34 (0.84)	11	0.44 (0.97)	12	0.50 (1.04)
Neighbor's home	2	0.05 (0.29)	1	0.02 (0.14)	2	0.04 (0.20)
Work	28	5.29 (5.23)	23	4.46 (5.28)	34	6.32 (5.19)
School	4	0.35 (1.3)	3	0.20 (0.90)	2	0.14 (0.70)
Market	8	0.14 (0.33)	7	0.14 (0.35)	8	0.16 (0.37)
Place of worship	7	0.41 (1.11)	3	0.20 (0.38)	4	0.12 (0.44)
Salon	1	0.04 (0.28)	0	—	0	—
Gym	2	0.12 (0.71)	3	0.14 (0.57)	1	0.06 (0.42)
Bar	5	0.28 (1.11)	4	0.38 (1.47)	3	0.30 (1.13)
Health center	0	—	0	—	0	—
Women's group	0	—	0	—	0	—
Transportation	29	0.72 (0.99)	19	0.64 (1.17)	19	0.50 (0.79)

Note. n = number of respondents with more than 0 for each setting; *SD* = standard deviation.

at work, and again the mean of differences was less than one hour (−0.45 hr, Table 5) and responses were correlated ($\rho = .77$), and internally consistent (Cronbach's $\alpha = .72$). For other settings, the average time spent in them was less than one hour and did not differ substantially between the previous day and typical weekday assessment, but correlation coefficients and Cronbach's α values were generally low.

Discussion

In this series of analyses, we assessed the validity of a new questionnaire instrument designed to measure time use in an African urban setting. We used a culturally sensitive approach to developing the instrument by basing it on a familiar game played by children and adults in Uganda and other African countries. The instrument was designed to attach a concrete meaning to the abstract concept of time by equating beads with a uniform period during the day. Overall, the estimates of the mweso game for time spent at

Table 4. Mean of Difference in Time and Spent in Different Time Use Settings and Correlation Among 50 Respondents Who Completed the 24-Hr Recall Survey and the Mweso Game Instrument, Including Mweso Previous Day and Mweso Typical Weekday.

	24-Hour Recall Survey Versus Mweso Previous Day			24-Hour Recall Survey Versus Mweso Typical Weekday		
Setting	Mean of Difference	95% Confidence Interval	ρ	Mean of Difference	95% Confidence Interval	ρ
Home	−.35	[−1.49, 0.78]	.73	0.63	[−0.48, 174]	.70
Relative's home	−.23	[−0.68, 0.23]	.43	−0.17	[−0.64, 0.31]	.35
Friend's home	−.10	[−0.31, 0.12]	.67	−0.16	[−0.39, 0.08]	.64
Neighbor's home	.03	[−0.06, 0.12]	−.02	0.01	[−0.09, 0.11]	−.03
Work	.83	[−1.28, 1.79]	.79	−1.03	[−2.16, 0.11]	.71
School	.15	[−0.01, 0.31]	.93	0.21	[−0.02, 0.43]	.87
Market	−.01	[−0.07, 0.06]	.80	−0.03	[−0.12, 0.07]	.57
Place of worship	.21	[−0.11, 0.52]	.40	0.29	[−0.02, 0.59]	.28
Salon	—	—	—	—	—	—
Gym	−.03	[−0.22, 0.17]	.46	0.06	[−0.18, 0.29]	−.02
Bar	−.1	[−0.30, 0.10]	.89	−0.02	[−0.18, 0.14]	.91
Health center	—	—	—	—	—	—
Women's group	—	—	—	—	—	—
Transportation	.08	[−0.19, 0.36]	.60	0.22	[0.01, 0.43]	.68

Note. ρ = Pearson correlation coefficient.

home or at work were most valid and reliable. Time use estimates in other settings were generally low but well correlated with the standardized 24-hr recall survey.

Criterion validity was evaluated by comparing the number of beads used to estimate the passage of time. We found that the participants readily understood the task, but the correlation between perceived time and actual time was only fair. The mweso game was best in estimating the duration of daylight each day and lowest when estimating time since the previous evening. Waiting time in the medical clinics was consistently overestimated, but the setting of the interview may have affected the volunteer's perception of time.

Construct validity was assessed by comparing the performance of the mweso game with a standardized and established questionnaire for assessing time use within the previous 24 hr (Kes and Swaminathan 2006). This

Table 5. Comparison of Baseline Assessments of Time Use During Previous Day and Typical Weekday Using the Mweso Game Among 568 Adult Participants.

Setting	Mean Previous Day	Mean Typical Weekday	Mean of Difference	95% Confidence Interval	ρ	Cronbach's α
Home	13.1	12.7	0.45	[0.07, 0.83]	.74	.70
Relative's home	0.07	0.05	0.02	[−0.03, 0.07]	.09	.08
Friend's home	0.25	0.24	0.02	[−0.09, 0.13]	.26	—[a]
Neighbor's home	0.02	0.05	−0.03	[−0.05, −0.01]	.40	.45
Work	9.42	9.87	−0.45	[−0.85, −0.05]	.77	.72
School	0.07	0.08	−0.02	[−0.08, 0.05]	.28	.50
Market	0.11	0.10	0.01	[−0.3, 0.06]	.34	.31
Place of worship	0.26	0.24	0.02	[−0.08, 0.11]	.52	.40
Salon	0.04	0.03	0.02	[−0.03, 0.06]	.16	.08
Gym	0.06	0.08	−0.2	[−0.73, 0.04]	.42	.67
Club	0.04	0.02	0.02	[−0.02, 0.05]	.49	.62
Bar	0.07	0.02	0.05	[0.00, 0.09]	.50	.72
Kiosk	0.06	0.07	−0.01	−0.03, [0.12]	.75	.69
Health center	0.02	0.01	0.01	[−0.02, 0.03]	−.00	—
Women group	0.01	0.01	0	[−0.01, 0.02]	−.00	—
Taxi/ transportation	0.15	0.13	0.02	[−0.02, 0.06]	.51	.33
Other	0.17	0.15	0.02	[−0.02, 0.06]	.68	—

[a]Unable to calculate Cronbach's α due to insufficient responses.

standard questionnaire resembles a diary, has established validity, and has been used in national surveys conducted in Africa by the United Nations Development Program and the United Nations Statistics Division to ascertain time use in relation to gender, health, and poverty. In this comparison, the recall of the previous day using the mweso game correlated well with the more detailed 24-hr survey across most time use settings. In fact, the difference in mean times spent in every setting was less than one hour. A similar level of correlation was found with the mweso game assessment of the typical weekday. Regarding internal reliability, we found that the assessments of time at home or at work afforded the greatest correlation and internal consistency with the mweso game. For other settings, the two estimates of time use were similar to within one bead or one hour.

Commonly used methods to measure time use include direct observation, diaries, and self-reported recall (Thomas Juster, Ono, and Stafford 2003). Direct observation is considered the most valid and reliable tool to measure

time use, but it may influence or change patterns of behavior in participants when under observation. Diaries may also be used to measure time use as they can provide detailed information about movement and activities, but they require motivated and literate participants who can spare the time to record in the diaries (Wiseman, Conteh, and Matovu 2005). In sub-Saharan Africa where both literacy and accurate time measurement may be low, diaries may not be an appropriate tool for measuring time use.

For this reason, we used self-report to measure time use in various social settings in Kampala. Because of concerns about literacy and the cultural concepts of time, we opted to use a pictorial approach to capture the self-reported patterns of time use in a setting where time of day may not be assessed with a watch or clock. Pictorial surveys have been used in other low-income settings to measure household expenditures (Wiseman et al. 2005), infant health and morbidity (Thomas et al. 2015), and time use in a rural setting (Masuda et al. 2014). In fact, the approach used in this study follows that used by Masuda and colleagues in assessing time use in Ethiopia with one important modification: Our instrument was patterned after a common and widely played game so as to enhance the cultural familiarity of the instrument.

As with all self-reported methods, our method is subject to several potential biases. First, the study was conducted in Kampala city where the educational levels are likely higher than in the rural parts of the country. So, the results may represent an optimistic evaluation of the mweso game performance. In addition, the pictures that are relevant in the urban environment may be less meaningful in a rural environment, so the mweso game may not transport directly to a rural population. Further development of this instrument could evaluate the mweso game in a rural setting. Second, social desirability is likely to occur as participants tend to overreport "good" behaviors and underreport "bad" behaviors. For example, time spent at church may be overreported, while time at a bar may be underreported.

Third, recall is also influenced by a cultural concept of time, so it may be difficult to project time into a 24-hr framework. In this questionnaire, self-report depends on correctly remembering the amount of time spent in a certain setting and expressing that time using the beads. Although prompts and cues may help with recall, the information may not be as accurate as direct observation or diaries. It is possible that the pictures used did not capture the full range of settings where residents of Kampala spend their time, so important venues may not have been measured.

Fourth, we did not vary the order in our questioning about previous day and typical day. As a result, it is possible that the responses given for the

settings from the previous day may have influenced the responses for a typical day, since we asked about previous day first. Further evaluation of the reliability would vary the order in which these questions were asked. Finally, criterion and construct validity were evaluated in different populations which may have influenced our results.

We have developed the mweso game as an easy-to-understand instrument to measure time use in the context of low education levels, minimal use of watches or clocks, and different cultural perceptions of time. The mweso game had fair criterion validity and very good to excellent construct validity. Reliability was best for assessments at home or at work. With further validation, it may prove to be a useful way to measure time use, especially in an African urban environment, and to study the relation between time use and transmission of infectious diseases like tuberculosis.

Authors' Note

Lauren M. Schwartz and Jane Mutanga contributed equally to this article.

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Supplemental Material

Supplemental material for this article is available online.

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