MEASURE OF ACCESSIBILITY TO URBAN INFRASTRUCTURES FOR ADULTS WITH PHYSICAL DISABILITIES (MAUAP): INTER-RATER RELIABILITY STUDY

Original clinical research

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ABSTRACT

Background: There is a challenge for rehabilitation professionals for assessing urban educational and pedestrian infrastructures and leisure facilities, to ensure accessibility for wheelchair users, blind and deaf people, and older adults with and without assistive devices. The Measure of accessibility to urban infrastructures for adults with physical disabilities (MAUAP) was developed to provide professionals with an objective and exhaustive measure of accessibility of exterior and interior urban infrastructures for adults with mobility, visual and hearing impairments. After the content development and the content validation with experts, the aim of this paper is to pursue the development of that measurement tool, the MAUAP, in evaluating inter-rater reliability.

Method: This process of developing a measurement tool in health involves an inter-reliability study which was performed by two occupational therapists. They completed 23 MAUAP evaluations of learning (educational) and leisure facilities as well as pedestrian infrastructures. Inter-rater reliability was evaluated using the Gwet's AC1 statistic.

Results: The MAUAP shows good inter-rater reliability indicators in all sections: parking lot, pedestrian facilities, building access from the exterior, interior manoeuvring areas, places for learning and leisure, services, and public restroom. The 133 items had AC1 values had values rating from good or excellent. Each section of the MAUAP can be used separately, according to the evaluator's needs.

Conclusions: Overall, the MAUAP is a reliable accessibility measure of urban built environments for adults with physical disabilities (mobility, visual, hearing) which can be used in order to favour clients' participation. This measure allows the identification of consistent accessibility recommendations and has been experimented with occupational therapists; however, the results of MAUP may interest health professionals and other professionals involved in conception and renovation projects, such as architects, and city planners.

Keywords: *Evaluation of built environment, assessment of accessibility, wheelchair mobility, inclusive design, public buildings; pedestrian facilities; educational and leisure facilities*

1. Introduction

The Measure of accessibility to urban infrastructures for adults with physical disabilities (MAUAP) was developed to measure the accessibility of urban infrastructures, including learning/educational, leisure, and pedestrian infrastructures for adults with physical disabilities (mobility, visual, hearing) [1]. The MAUAP assesses the accessibility of exterior and interior urban built environments, including seven types of urban infrastructures: parking lot, pedestrian facilities, building access from the exterior, interior maneuvering areas, places for learning and leisure, and public restroom. It has been developed to address the problems in regards to existing accessibility measures (see background below), being the absence of a comprehensive measure considering physical disabilities (mobility, visual, hearing) for both exterior and interior urban infrastructures. A literature review was performed and accessibility criteria gathered to create a first draft, which has been validated by experts in municipalities, research and health [1].

1.2 Background

The measurement properties of many measures have poor to moderate indicators [2-6]. Those with good reliability and validity indicators were, as mentioned, restrained in the targeted environments and populations [4, 7-17]. The lack of standardized and validated general measure of accessibility of exterior and interior infrastructures for adults with physical disabilities hinders the ability of health professionals to propose proper environmental configurations.

Given that health professionals promote accessibility in the community to encourage participation [8, 17-20], such a measure would be particularly helpful in order to inform clients and to propose adaptations and recommendations in design and building projects [17, 19, 21-23]. It allows health professionals to objectively quantify their observations, to analyze and to propose accessibility measures or adaptations in conception (from plan analysis) or renovation (from existing built infrastructures) projects useful in decision making. Moreover, health professionals should cooperate with professionals in design and architecture to propose design solutions adapted to IPD, as well as to clarify the definition of concepts such as accessibility and universal design, which differ in both contexts but would need to be understood and common to both grounds.

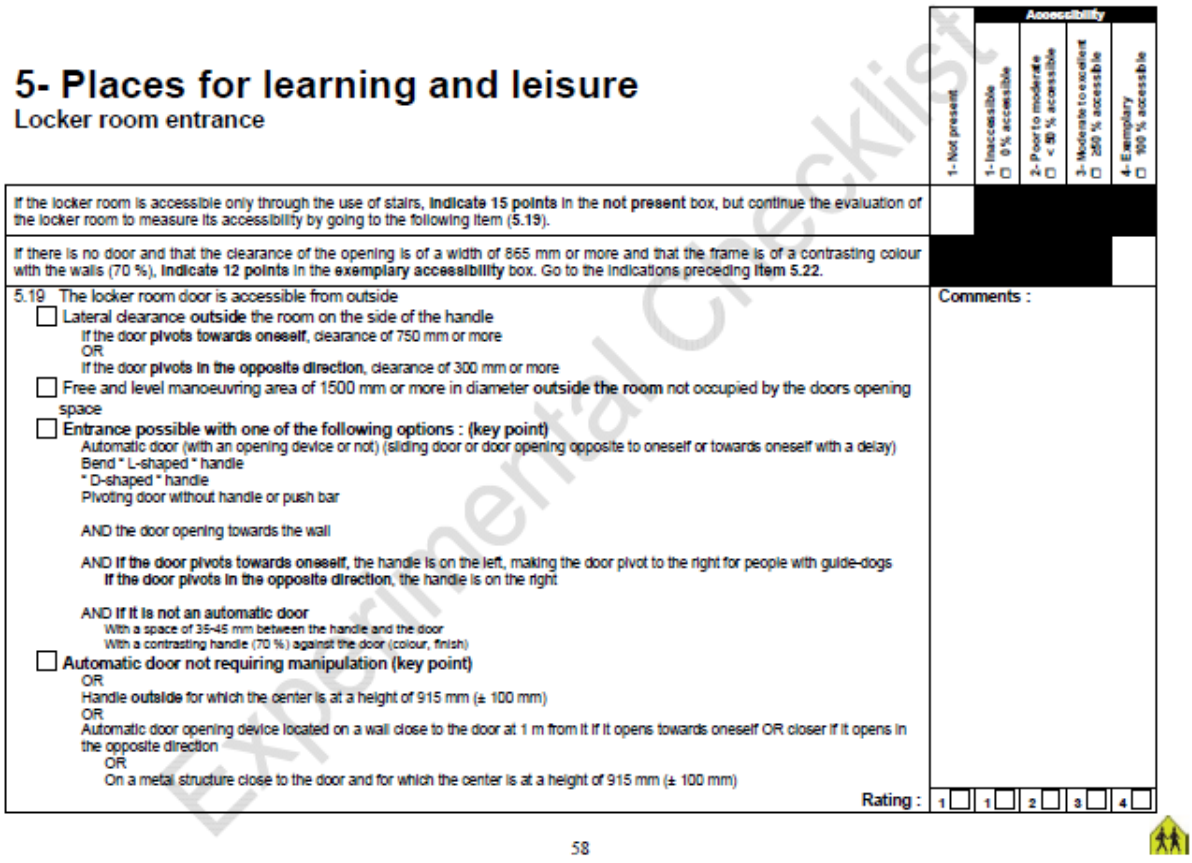
In architecture, it has been proposed that the concept of spatial accessibility is a characteristic of the environment [24]. It is composed of four dimensions: 1) spatial orientation, 2) communication, 3) displacement, and 4) use [24]. These dimensions also consider the subjective aspect of space. Spatial orientation designates the understanding of space via its configuration and signage for intuitive navigation; communication refers to potential information sources (human and technological); displacement represents conditions (safety, continuity, comfort, etc.) supporting mobility; and use is related to the potential for use of the environment [24]. Such a conceptual idea has no equivalent concept in occupational therapy.

1.3 The MAUP

The experimental version of the MAUAP was initially developed in French and translated into English (http://www.cirris.ulaval.ca/sites/default/files/documents/mauap_english_version2.pdf). The MAUAP's development was based on 13 measures found in the literature and seven public documents concerned with norms, regulations and accessibility indicators [1]. The MAUAP includes 7 sections, or variables, which are in fact types of urban infrastructures that account for all necessary environmental elements required for accessibility: 1) parking lot (11 items), 2) pedestrian facilities (11 items), 3) building access from the exterior (17 items), 4) interior manoeuvring areas (12 items), 5) places for learning and leisure (33 items), 6) services (26 items), and 7) public restroom (23 items).

All sections and items can be considered as independent measures. Four different levels of content are present in the measure, which are a) the variables (the seven sections), b) the subvariables (elements found within each urban infrastructure), c) the items which are checklists of characteristics (affirmative sentences related to signage, accessibility (space and usability), safety and specific equipment (if any) for each subvariable), and d) the characteristics (observable and quantifiable aspects defining the evaluated environments). Since items are presented as checklists of characteristics, the evaluator checks each characteristic if present, and otherwise leaves it unchecked. To further characterize the degree or level of accessibility, the evaluator computes the percentage of characteristics present per item, and attributes an accessibility score on the 4-level rating scale of accessibility (percentage ranges of checked characteristics). Comments can also be added and need to be analyzed alongside

the unchecked characteristics to truly make sense of the level of accessibility of the environment. Figure 1, extracted from page 58 of the MAUP, illustrates one aspect of the section 5 with the variable (5- Places for learning and leisure), the sub-variable locker room entrance, the item 5.19 The locker room is accessible from the outside, and five observable and measurable characteristics are announced with a ☐. At the right, the four rating scale indicates not present or inaccessible (1) to exemplary accessible (4) and space to add comments.



5- Places for learning and leisure

Locker room entrance

Accessibility

1- Not present | 1- Inaccessible ☐ 0 % accessible | 2- Poor to moderate ☐ < 50 % accessible | 3- Moderate to excellent ☐ ≥50 % accessible | 4- Exemplary ☐ 100 % accessible

If the locker room is accessible only through the use of stairs, **indicate 15 points** in the **not present** box, but continue the evaluation of the locker room to measure its accessibility by going to the following item (**5.19**).

If there is no door and that the clearance of the opening is of a width of 865 mm or more and that the frame is of a contrasting colour with the walls (70 %), **indicate 12 points** in the **exemplary accessibility** box. Go to the indications preceding **item 5.22**.

5.19 The locker room door is accessible from outside

Comments :

☐ Lateral clearance **outside** the room on the side of the handle
- If the door **pivots towards oneself**, clearance of 750 mm or more
- OR
- If the door **pivots in the opposite direction**, clearance of 300 mm or more

☐ Free and level manoeuvring area of 1500 mm or more in diameter **outside the room** not occupied by the doors opening space

☐ **Entrance possible with one of the following options : (key point)**
- Automatic door (with an opening device or not) (sliding door or door opening opposite to oneself or towards oneself with a delay)
- Bend " L-shaped " handle
- " D-shaped " handle
- Pivoting door without handle or push bar

AND the door opening towards the wall

AND **If the door pivots towards oneself**, the handle is on the left, making the door pivot to the right for people with guide-dogs
If the door pivots in the opposite direction, the handle is on the right

AND **If it is not an automatic door**
- With a space of 35-45 mm between the handle and the door
- With a contrasting handle (70 %) against the door (colour, finish)

☐ **Automatic door not requiring manipulation (key point)**
- OR
- Handle **outside** for which the center is at a height of 915 mm (± 100 mm)
- OR
- Automatic door opening device located on a wall close to the door at 1 m from it if it opens towards oneself OR closer if it opens in the opposite direction
- OR
- On a metal structure close to the door and for which the center is at a height of 915 mm (± 100 mm)

Rating : 1☐ 1☐ 2☐ 3☐ 4☐

58

Figure 1. Extracted page of the MAUP giving an example of what the evaluator should consider before rating for accessibility

After the content development and the content validation with experts [1], the **aim of this paper** is to pursue the development of that measurement tool, the MAUAP, in evaluating inter-rater reliability. We believe that standardized measures concerned with a specific construct which are stable from one rater to another are the basis for effective and objective practices [25].

2. Research methods

A cross-sectional research design of health measure development was applied for inter-rater reliability study [25]. This inter-rater reliability study involves two occupational therapists as raters. The research protocol was reviewed and approved by the ethics committee of the *Institut de réadaptation en déficience physique de Québec* (Quebec City, Canada, project # 2010-218).

2.1 Environmental sampling

A convenience sample of urban infrastructures was chosen to allow the evaluation of all variables and types of infrastructures targeted by the MAUAP: pedestrian, learning (educational) and leisure infrastructures. These infrastructures were identified with the community, municipal, and health representatives consulted (n=14) to ensure content validity during the development process of the measure [26]. A diversified sample of infrastructures was chosen and a variety of building types and styles was visited. The number and types of assessed infrastructures are presented in table 1.

Table 1. Number and types of infrastructures assessed

Specific types of infrastructures	**n**
Learning (educational) infrastructures for adults	
Professional training center	2
Post-secondary institutions excluding university (CEGEP)	5
University building	8
Leisure infrastructures for adults	
Arena	3
Community center	7
Library	13
Pedestrian facilities	23

2.2 Procedure

In order to evaluate the MAUAP's inter-rater reliability, two occupational therapists with clinical experience in accessibility evaluations performed the MAUAP evaluations in the same infrastructures. Rater 1 (SG) was a master student in rehabilitation sciences and an occupational therapist. Rater 2 (LR) was an occupational therapist. After a 2-hour training session with the first author (SG), they independently performed 23 evaluations each. The material used included a measuring tape, an inclinometer, a measuring wheel, a luxmeter, a sonometer, a chronometer, a

calculator and the electronic version of the measure on an electronic tablet.

2.3 Data analysis

Inter-rater reliability of each of the MAUAP's items was analyzed with the Gwet's AC1 statistic which is defined as the conditional probability that two randomly selected raters will agree, given that no agreement will occur by chance [27, 28]. Unweighted Gwet's AC1s were calculated for all items independently, which are checklists composed of characteristics (dichotomous score). Weighted Gwet's AC1s were used for items using the 4-level ordinal scale to assess the percentage of elements present, those are items 5.16, 6.16, 6.17, and 6.18. Cohen's Kappa values, the percentage of agreement, and the percentage of agreement when both raters observe the environmental characteristics were also calculated. Gwet's AC1 values were interpreted as representing poor (0.00 to 0.40), moderate (0.41 to 0.60), good (0.61 to 0.80) or excellent (0.81 to 1.00) agreement between the raters. The greater the value, the higher the percentage of agreement between raters is compared to what chance would have produced [25]. Data were analyzed with AgreeStat 2011. To meet our objective, we made the hypothesis that the Gwet's AC1 values for all the MAUAP's items would be high (≥0.61, being good or higher).

3. Results

Figure 2 shows the distribution of inter rater reliability coefficients, including Gwet's AC1 and Cohen's Kappa values, for all items. Full Gwet's AC1 and Cohen's Kappa statistics are accessible on the CIRRIS' extradata, cirris.ca/mauap.html. The inter-rater reliability analysis for the items showed Gwet's AC1 ranging from 0.63 to 1.00, representing good to excellent indicators. Most items have a Gwet's AC1 greater than 0.80, meaning very good agreement between raters beyond chance factors. One item (5.26) did not provide a Gwet's AC1 since it was never observed by the raters. The range for the percentage of agreement for items is from 0.804 to 1.000. Even though few items presented low Kappa values, their percentage of agreement was high as well as their Gwet's AC1.

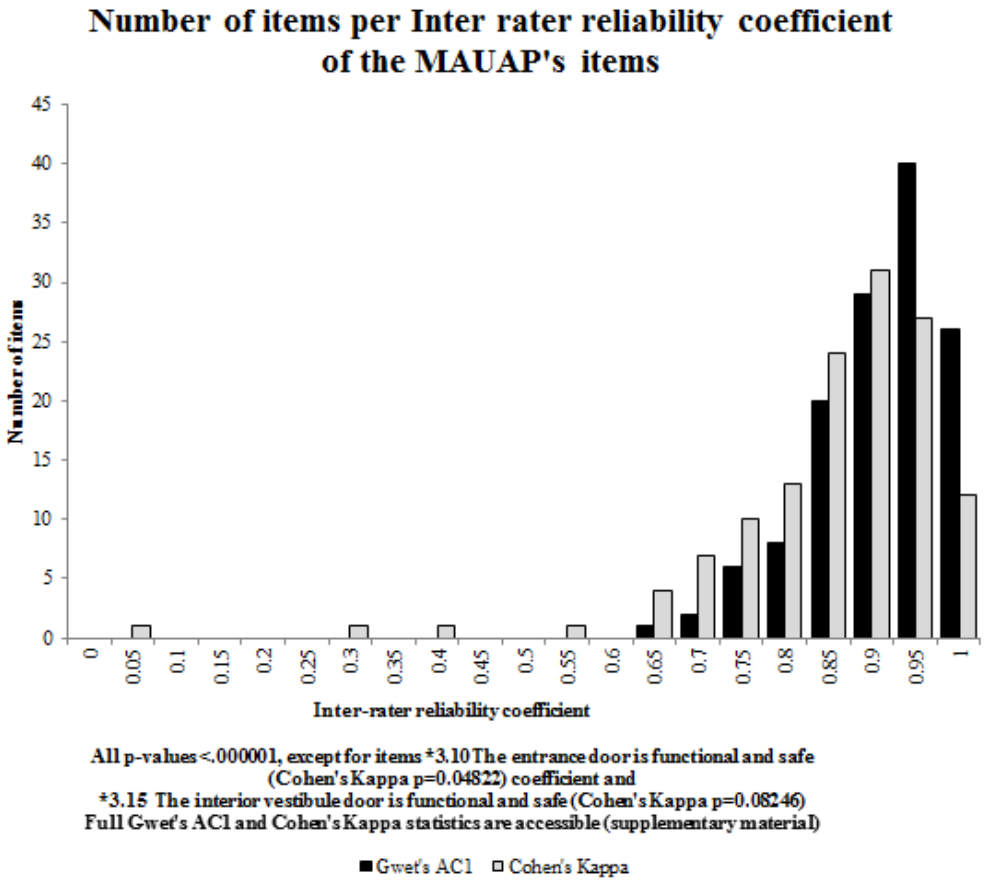


Figure 2. Inter rater reliability coefficients of the MAUAP's items (n_{max}=133 items)

4. Discussion

This study met the objective to evaluate the MAUAP'S inter-rater reliability, a measure of accessibility to urban infrastructures (parking lot, pedestrian facilities, building access from the exterior, interior manoeuvring area, places for learning and leisure, services, public restroom) for learning and leisure as well as pedestrian infrastructures for adults with physical disabilities (mobility, visual, hearing). All items have good to excellent inter-rater reliability indicators (Gwet's AC1), which supports our hypothesis of the MAUAP's items having good Gwet's AC1 values or more. Hence, the MAUAP is a reliable measure allowing accessibility evaluation of learning, leisure and pedestrian infrastructures for people with physical disabilities.

Even though some items have lower Cohen's Kappa, their Gwet's AC1 shows good to excellent values, their percentage of agreement being also high. The lower Kappa values could therefore be explained by two different situations: 1) the item's characteristics (to be checked off) were almost or never present, or 2) the item's

characteristics were almost or always present. On the basis of the results obtained, no major modifications should be made to the rating scale. However, content might be improved to shorten the time required to use the measure and to add the consideration of other individuals such as those with intellectual and cognitive disabilities. However, it should be noted that the clarity of the items and of the rating scale might explain the good agreement percentages of the items and that modifications should therefore be well thought of before been implemented. Such might not have been the case for other measures found in the literature which generally have lower coefficients for reliability. Many measures evaluated for their measurement properties have poor to moderate indicators [5, 6, 29-31]. Those with good reliability and validity indicators were restrained in the targeted environments and populations [7, 10, 11, 13, 15, 31-37]. Now having a reliable and comprehensive measure of accessibility in terms of populations considered and targeted infrastructures, the evaluation of public infrastructures for the aging population and for those with mobility impairments will allow the identification of problems to better find effective solutions and create more inclusive contexts.

4.1 Limits of the study

The sample size (number of evaluated infrastructures) used for the evaluation of inter-rater reliability was limited and extreme levels of accessibility, such as exemplary accessibility, might not have been observed within the sample. In fact, all evaluated infrastructures were in the city of Quebec and might have not provided enough diversity. Since most of the evaluated infrastructures did not present every variable evaluated in the MAUAP, it was necessary to use as many infrastructures as needed to complete the entire evaluation, being the seven sections of the MAUAP. In other words, when an infrastructure did not have a library for example, we sometimes had to evaluate one outside of a targeted infrastructure. Therefore, more than 23 infrastructures were evaluated to complete a total of 23 evaluations. Moreover, the number of evaluators (n=2) was limited and might not have been representative of all types of occupational therapists.

Two observers is a very small number to establish inter-observer variability. Statistically, high agreements are obtained when both raters believe that a characteristic is not present. It does not necessarily mean that their judgment is accurate. With the actual MAUAP

directives, the characteristic was perhaps hard to detect rather than absent. Also, when both raters detected a characteristic, we did not check if their assessment was based on the observation of the same elements. Therefore, the agreement between raters might be questioned.

Finally, another source of bias, related to the measure's internal validity, was the climatic issues that arose when exterior evaluations took place. The data collection took place in the winter months in Quebec City (Canada), a nordic city, with high precipitation and snow accumulation levels. The weather could have influenced the raters' ability to evaluate infrastructures.

4.2 Future research

Future research with the MAUAP should consider seasonal factors when assessing exterior variables in order to determine whether the climate influences accessibility. We invite researchers to pursue validation of the MAUAP: French and English versions are available on the web [38]. Further testing could also allow reconsideration of the sample to include infrastructures that were almost never present in this study (e.g. trains or bus stations, platform lifts). It would also be interesting to integrate characteristics allowing the evaluation of accessibility for individuals with intellectual and cognitive impairments in the measure's content. The adaptation of the format could also be considered for greater accessibility and usability of the document for individuals with visual disabilities and other professionals concerned with accessibility (e.g. architects, groups defending the rights of individuals with physical disabilities). The possibility of structuring the measure in order to obtain a total score that is truly representative of the level of accessibility of an infrastructure is to be explored. A co-design approach for the development of a new version with individuals with disabilities should also be considered. Inter-rater reliability should be further evaluated with other professionals such as architects and urban planners or with individuals who are not experts in construction or rehabilitation (e.g. representatives of disabled people's group). It could potentially also be used in the construction industry and by individuals in general concerned with accessibility issues. These individuals will then have access to an assessment tool that can be used before renovations or at the beginning of a construction project to ensure accessibility of existing and future

urban infrastructures for individuals with physical disabilities.

5. Conclusion

The MAUAP is a reliable measure of accessibility of exterior and interior urban infrastructures for adults with mobility, visual and hearing impairments. This measure shows good inter-rater reliability for its use by occupational therapists. They can use this reliable tool to indicate adaptations for improving accessibility; therefore, promoting the exchange of accessibility solutions with architects, urban planners, and decision makers. Future research could include the use of the MAUAP by those other individuals to create a common ground and vocabulary on which to work on in conception and renovation projects.

The implications for rehabilitation are: 1) The MAUAP is an objective measure of accessibility of exterior and interior urban infrastructures for adults with physical disabilities (mobility, visual, hearing) which can be used in order to favour clients' participation. 2) The MAUAP shows good inter-rater reliability indicators in all sections: parking lot, pedestrian facilities, building access from the exterior, interior manoeuvring areas, places for learning and leisure, services, and public restroom. 3) Each section of the MAUAP can be used separately, according to the evaluator's needs.

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