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Assessment and Analysis of Housing Accessibility: Adapting the Environmental Component of

the Housing Enabler to United States Applications

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Abstract

The home environment is a primary context for daily activities, especially among older adults and persons with disabilities. Functional and age-related decline can generate problems in relation to certain environmental features, necessitating modifications or other provisions of support. The determination of appropriate home interventions is best served using a person-environment (P-E) fit approach, which considers both environmental barriers and functional limitations in measuring the magnitude of accessibility problems. In the United States (U.S.), there are few valid and reliable instruments utilizing this approach. This study aimed to adapt the environmental component of the Swedish Housing Enabler (HE) for valid use in the U.S., and furthermore investigate the inter-rater agreement of the instrument. Statistical analyses of fifty pairwise home assessments show the environmental component of the U.S. HE to be sufficiently reliable ($\kappa = 0.410$, percentage of agreement = 81%) for the region of study. A valid and reliable U.S. HE has the potential to inform appropriate housing environment interventions and therefore improve U.S. housing stock, the majority of which is currently considered inaccessible for residents with functional limitations.

1. Introduction

Worldwide, the proportion of older adults and persons with disabilities is steadily increasing (World Health Organization [WHO], 2013). With a global rise in age and disability, the need for appropriate environments that allow for participation and engagement in daily activities and prevention of future impairments is great (WHO, 2011). The home environment is a primary context for personal (P-) and instrumental activities of daily living (I-ADL), and properly designed housing helps support independence and daily functioning (Wahl et al., 2009). The common desire of older adults and persons with disabilities to live independently necessitates home environments that accommodate and provide proper support for necessary and desired activities (Horowitz et al., 2013; Smith et al., 2008).

The concept of person-environment (P-E) fit suggests that an appropriate balance between a person's functional competence and his/her environmental surroundings is important in maintaining overall health and well-being (Carp and Carp, 1984; Kahana, 1982). Lawton and Nahemow's (1973) Ecological Theory of Aging (ETA) posits that persons with lower competence are more susceptible to environmental demands than those with higher levels of competence. Fundamentally, Lawton (1974) argued that maladaptive performance and behavior can result from poorly designed, unsupportive environments that do not accommodate daily needs. In other words, the magnitude of environmental issues present in a person's home is a product of his/her overall capacity to adapt to or overcome such barriers (Iwarsson, 2005).

According to Lawton (1990), environmental modifications can reduce environmental press, or stressors that inhibit the capability to perform activities of daily living. Modifications to the home help support independent living by reducing the impact of the environment on a person's daily function (Fänge and Iwarsson, 2005). Modifications or interventions can be made

more appropriate and efficient through the use of a P-E fit approach involving comprehensive assessments that evaluate the impact of environmental barriers in the home in relation to the functional profile of the inhabitant (Iwarsson et al., 2009). Using the P-E fit perspective, the balance, or match, between a person's abilities and the challenges of his/her environment can be determined. This balance, otherwise known as accessibility, is based upon standards for design of built environments that can be observed and objectively measured (Iwarsson et al., 2012).

According to Maisel et al. (2008), the majority of the housing stock in the U.S. is considered inaccessible to persons with disabilities, risking health, safety, and potential relocation or institutionalization. In 2010, the U.S. Census Bureau reported that 31.3% of Americans were living with a disability, with older adults at highest risk of having a disability requiring assistance. In fact, one in four households aged 65-74 includes at least one member with a disability, which grows to almost two-thirds of households aged 85 and older (Center for Housing Policy, 2012). Furthermore, 78.7% of older adults aged 65 and older live in owner-occupied housing units (U.S. Census Bureau, 2012a), the majority of which have barriers limiting access into and out of the home (Maisel et al., 2008).

Home interventions informed through comprehensive, P-E fit focused assessments can help identify appropriate modifications or supports of highest need. Similarly, assessing the suitability (and not just housing quality, as measured in current national surveys) of U.S. housing for inhabitants with different needs can assist in directing funding or programming necessary to modify the housing stock to foster and support independent living also for older adults and persons with disabilities (Center for Housing Policy, 2012). Although there is a clear, identified need for improved housing accessibility indicators for use in policy and practice, there are currently few valid and reliable instruments to measure the presence and magnitude of

accessibility problems within a person's home, especially in the U.S. (Mitty, 2010).

1.1. The Housing Enabler Instrument

One promising instrument for the assessment of P-E fit and accessibility in home

environments is the Housing Enabler (HE; Iwarsson and Slaug, 2010). The HE has been

established as a reliable and valid means of evaluating physical accessibility problems (Iwarsson

et al., 2012), and has been used in numerous empirical studies in Europe (e.g., Helle et al., 2012;

Iwarsson, 2005; Nygren et al., 2007; Oswald et al., 2007). The basis of the HE instrument is

congruent with the ETA (Lawton and Nahemow, 1973), and was constructed based on the notion

of P-E fit.

By means of the HE, a person is objectively assessed of his/her functional limitations

(including dependence on mobility devices) while the home environment is assessed for

prevalence of physical environmental barriers that—according to the national standards for

housing design and construction—may threaten accessibility. Based on the Enabler Concept

(Steinfeld et al., 1979) but originally developed in Sweden (Iwarsson and Isacsson, 1996), the HE

includes a three-step assessment and analysis procedure: 1) a dichotomous assessment of a

person's functional capacity (12 items on functional limitations and 2 items on dependence on

mobility devices); 2) a dichotomous assessment of the physical environmental barriers in the

home and the close exterior surroundings (161 items); 3) the calculation of an overall magnitude

of accessibility problems score (ranging from zero to a theoretical maximum of 1,832). In cases

where the individual does not have any of the functional limitations covered by the instrument, the

score is always zero, equating to no accessibility problems. Physical environmental barriers can also

be rank-ordered based on their contribution to the total accessibility problems score. This

computation generates environmental barrier item-specific P-E fit scores and results in a list

ranking the environmental barriers from those generating the highest magnitude of accessibility problems to the least, on an individual or group level. That is, quantifying objective P-E fit using the HE instrument helps determine the magnitude of accessibility problems anticipated within the home environment as well as why such problems might occur (Iwarsson et al., 2012).

With the environmental component of the instrument (Iwarsson and Slaug, 2010), accessibility problems and environmental barriers defined by housing regulations and legislation in a Swedish context can be assessed. Among the 161 items in the HE environmental component, 70 are specified according to measurable standards, while 91 are to be assessed based on professional judgment. The environmental component is divided into three subsections: A) exterior surroundings (28 items); B) entrances (46 items); C) indoor environment (87 items). Each item is dichotomously assessed—"yes" meaning the barrier exists, and "no" signifying that the barrier does not exist. In addition, there is a "not rated" response option, to be used only when an environmental feature cannot be assessed (e.g., when access is not granted by the inhabitant, communal spaces are locked, or weather conditions prohibit the assessment).

The Swedish HE has undergone numerous iterations, adopting some new features and eliminating others (Iwarsson and Slaug, 2010; Iwarsson et al., 2012). Through the ENABLE-AGE Project (Iwarsson et al., 2007), a cross-national version adapted for reliable and valid use for research purposes in five European countries was established. More recently, the environmental component of the HE was adapted to a Nordic context, including Sweden, Finland, Iceland, and Denmark (Helle et al., 2010). In each of these versions, methods of adaptation to different national contexts followed specific guidelines (see Helle et al., 2010; Iwarsson et al., 2005), including strict adherence to national standards for housing design addressing accessibility, validation of content using experts representing multiple disciplines and

professions, and systematic translation to the respective languages. At present, the 2010 version of the HE is available in Swedish, British English, and Danish, and a German version will be available in the near future.

Although the Enabler Concept was conceived in the U.S. as a means to move toward a national standard of barrier-free design (Steinfeld et al., 1979), the HE instrument itself does not match regulations in the U.S. and has not been validly established in a U.S. context. Housing stock and standards are different between Europe and the U.S., necessitating adaptation of the HE to U.S. applications. Establishing a reliable and valid U.S. version has the potential to inform the suitability of U.S. housing for older adults and persons with disabilities, as well as appropriate environmental modifications and supports based on a person's functional profile. On a population level, the HE can strengthen U.S. national surveys measuring housing quality through the inclusion of indicators of accessibility problems that threaten independent living. From a research perspective, the availability of an instrument that can be used for national and cross-national studies would be an asset for the much needed knowledge generation in this field of inquiry.

Therefore, the purpose of the present study was to adapt the environmental component of the HE (Iwarsson and Slaug, 2010) for valid use in the U.S. More specifically, we aimed to adapt the 161 environmental component items to meet U.S. accessibility standards and guidelines. As an additional aim, we investigated the inter-rater agreement of the environmental component as an indicator for reliable future use of the U.S. adapted version of the HE.

2. Methods

The procedures for establishing content validity and investigating multi-professional inter-rater agreement outlined by Iwarsson et al. (2005) and Helle et al. (2010) were employed. The systematic procedure required two comprehensive steps. The first step included adapting the

environmental component of the British English HE version (Iwarsson and Slaug, 2010) to a content valid U.S. version. The second step involved rater training, and subsequent pairwise assessments of 50 home environments to evaluate the inter-rater agreement of the environmental component.

2.1. Adaptation of the Environmental Component of the HE to a U.S. Context

The adaptation process began by translating all 161 environmental assessment items from the British English version of the HE (Iwarsson and Slaug, 2010) to American English, to ensure items would be content valid and understood in a U.S. context. Next, complete and current accessibility guidelines from the Department of Justice (DOJ), American National Standards Institute (ANSI), Americans with Disabilities Act (ADA), Federal Housing Act (FHA), and the International Building Codes (IBC) were obtained. The U.S. researchers searched for existent equivalent standards and guidelines that matched all 161 HE environmental component items. Equivalent item guidelines between DOJ, ANSI, ADA, FHA, and IBC regulations were organized side-by-side in a matrix. Once item-specific guidelines were organized, dimensions were converted from metric to Imperial units of measure.

Next, each item and its equivalent U.S. specification of standards and guidelines were analyzed based on the systematic comparison approach for content validity used in previous HE adaptations (Helle et al., 2010; Iwarsson et al., 2005). In many cases, the item specifications among the five sets of regulations were identical. When varied, decisions regarding which specification to include in the U.S. HE were made first by the U.S. researchers, and thereafter triangulated by a research assistant familiar with U.S. building codes. Outstanding questions regarding the specifications of environmental items were further validated through collaboration with Swedish counterparts to ensure valid cross-national comparisons.

The adaptation process for the final version of the environmental component of the U.S. HE resulted in 34 changes from the original. Differences were attributed solely to the variation in standards between Sweden and the U.S. The majority of the differences between HE versions were found in items representing the indoor environment (see Table 1).

2.2 Inter-Rater Agreement of the U.S. Version of the Environmental Component of the HE

To ensure that the environmental component of the U.S. HE could be reliably used in research and practice, an inter-rater agreement study was conducted. Formal ethical review and approval was not needed, as this study only involved assessments of home environments. That is, no data on humans was collected. Regardless, all raters completed and passed the online ethics course available to U.S. researchers prior to data collection to ensure the ethical execution of research.

2.2.1. Study district

The home environments selected were located in both urban and rural areas in a wide-ranging region of one state in the U.S. Pacific Northwest. According to the U.S. Census Bureau (2012a), at the time of the study the total state population was 3,899,353. Most residents (85.2%) were white, 64.8% completed some college education or higher, 61.6% lived in owner-occupied housing, and 13.9% identified with a disability. Of persons aged 65 and older (14.9% of the population), 94% were white, 57.6% completed some college education or higher, 76.8% lived in owner-occupied housing, and 37.5% identified with a disability. The state contained 1,682,531 housing units, 63.7% of which were one-unit, detached, single-family homes (U.S. Census Bureau, 2012b).

2.2.2. Sampling.

Fifty home environments were chosen by convenience (i.e., only houses where raters

knew the inhabitants), following specific inclusion criteria for housing type. That is, traditional

single-family and multifamily housing (e.g., apartments, condos, townhomes) were included

while group homes, cooperative homes, and supportive housing for older people were excluded.

Care was taken to ensure a representative mix of housing environments across multiple regions

of the state. Permission to assess the home was given by inhabitants, and raters accommodated

personal schedules. Confidentially was ensured through use of a coding system.

2.2.3. Procedures

Raters were undergraduate students in the upper division stage of the interior design and

housing studies programs at the U.S. researchers' institution. Their knowledge of housing design,

accessibility guidelines, and building codes was substantial, as required for the degree program.

Well ahead of the present study, the U.S. researchers underwent a 5-day rater training course

convened by the originators of the HE. Under said mentorship, the U.S. researchers administered

HE training and supervision of the 13 raters over the course of two academic terms, prior to data

collection and throughout the fieldwork process. Training activities and documents for U.S.

raters were based on the HE course format developed by the originators of the HE. In order to

identify initial misunderstandings and reduce discrepancies between measurement and

interpretation of items, all raters conducted one U.S. HE environmental assessment prior to the

training. Training included thorough discussions on item definitions, in-depth examination of

each environmental barrier item and further clarification of questions that arose from practice

assessments.

The raters were organized in pairs. As student participants' schedules prevented full

retention between academic terms, rater pair constellations were not fixed but varied with a total

of 11 different pairs engaged. Each rater within a pair independently assessed each home

environment within one week of one another. Immediately following each home assessment, rater

pairs completed a pairwise rating sheet that identified differences in ratings. Pairwise rating

sheets and full environmental assessment forms were submitted to the first author as assessments

were concluded. Cross-checking between assessment forms and pairwise rating sheets was

performed by a thorough and complete proofreading of each assessment before data were

digitized.

2.2.4. Data Analysis

Once pairwise data were collected and aggregated, data were analyzed using StataIC 12

and SAS 9.2. Percentages of agreement and Cohen's kappa (Cohen, 1960) were calculated

between rater pairs and across all 161 environmental barrier items to evaluate the inter-rater

agreement of the U.S. HE environmental component. Cohen's kappa statistic is considered a valid

measure of agreement that accounts for inter-observer agreement due to chance, especially when

an existing scale is already deemed reliable and valid (Altman, 1999; Cohen, 1960). Since a

significant limitation of kappa relates to its dependency on prevalence (Hallgren, 2012; Sim and

Wright, 2005), percentages of agreement were also calculated between raters and across all items.

Analysis of inter-rater agreement for the U.S. HE followed the same procedures and

standards set forth through previous adaptations of the original HE (Helle et al., 2010; Iwarsson

et al., 2005). Individual and mean values of kappa and percentage of agreement were calculated

for each item and subgroup of the environmental component. Appropriate kappa values were

defined as <0.20 = poor agreement, $0.21 - 0.41$ = fair agreement, $0.41 - 0.60$ = moderate

agreement, $0.61 - 0.80$ = good agreement, and $0.81 - 1.00$ = very good agreement, following

Altman's (1999) guidelines. Regarding percentage of agreement, good agreement was defined as

$>80\%$ agreement with a $k > 0.61$ and moderate agreement was defined as $>80\%$ agreement with a

k > 0.41 (as outlined by Iwarsson et al., 2005).

3. Results

The mean percentage of agreement for the environmental component of the U.S. HE was greater than 80% across all 161 items, while the mean kappa value indicated moderate agreement ($\kappa = 0.410$; see Table 2). More specifically, 110 items obtained a percentage of agreement at or above 80%, 34 items obtained 70 – 79% agreement, and 17 items had less than 70% agreement. Kappa values ranged from very good to poor. A large number of kappa values (75 items) demonstrated moderate to very good agreement and the majority (126 items) fell within the fair to good range (see Table 3).

In terms of the agreement of the three environmental component subsections, subsection A (exterior surroundings) demonstrated the lowest percentage of agreement (77%) but had the best mean kappa, indicating moderate agreement. Subsections B (entrances) and C (indoor environment) had percentages of agreement above 80%, while kappa values indicated fair agreement. Both measurable and professional judgment items had percentages of agreement above 80%. Measurable items had a mean kappa score in the moderate range, while professional judgment items had a kappa score in the fair range (see Table 2). Fifteen items with the lowest kappa values were accompanied by percentages of agreement ranging from 88-99%.

4. Discussion

Following similar procedures to studies adapting the Swedish HE to other cross-national applications (i.e., Helle et al., 2010; Iwarsson et al., 2005), as reported in the present study a content valid environmental component of the HE was created for use in the U.S. The results show moderate inter-rater agreement across mean kappa values and percentages of agreement. The better consistency between raters was found among measurable items and items related to

environmental barriers more commonly found in housing in the U.S. Professional judgment

items, or those more subjective in nature, would likely see improved agreement with more

thorough rater training and supervision. As such, continuing studies exploring inter-rater

agreement of the U.S. HE should contribute to improvements in overall reliability.

The establishment of a U.S. version of the HE has multiple implications for policy and

practice. The instrument can be used to determine overall magnitude of accessibility problems,

including rank-ordered environmental barriers in terms of priority, through simple yet

comprehensive dichotomous assessments of the environmental and personal components of P-E

fit. Practitioners can use the U.S. HE to determine interventions aimed at ensuring appropriate

housing conditions for clients' optimal comfort and performance, even as needs change over

time. Policymakers, designers, planners, and public health professionals can utilize such

information on a population level to understand the suitability of existing housing stock to

support decisions regarding funding for or implementation of appropriate modifications, plans,

or design guidelines on a national or community scale. Moreover, adding the U.S. HE to existing

and future versions adapted to multiple countries provides the means for needed cross-national

research. Thus far the U.S. has not been involved in substantial international research focused on

P-E fit and accessibility. Creating a U.S. version of the HE allows for comparisons, knowledge

building, and collective exploration and development of appropriate interventions within the U.S.

as well as among and between countries that encourage and support independent living across

the lifespan.

Using a theoretical P-E fit approach, the HE heightens the conceptualization and

quantification of accessibility beyond technical standards to the achievement of a balance, or

match between a person's abilities and the challenges of his/her environment. This approach has

the potential to enhance and improve current built environment policies across the U.S. as well as add the needed dimension of appropriate suitability of housing to our current conceptualization of housing quality for different user groups with specific needs, both in measurement and policy. Still, we are well aware that the objective assessment of P-E fit based on housing standards and norms has been criticized as reductionist without regard to perceptions and experiences of the P-E interaction (Helle et al., 2012). Therefore, adapting the HE to U.S. applications may be perceived as a step away from the universal design perspective currently gaining attention. However, the universal design approach is possible for new-build housing and major renovations, while most people in the U.S. and globally live in homes designed and built without the benefit of universal design approaches. Therefore, assessments based on valid accessibility standards provide an appropriate guide for housing renovation or home modification processes to improve the overall quality and suitability of housing. Further, a greater understanding of P-E fit and the adaptive processes people employ to maintain optimal P-E fit can supplement norm-based objective assessments. Most important, it is recommended that the HE be used in combination with other instruments that assess perceived aspects of housing (e.g., four-domain model of perceived housing in very old age; Oswald et al., 2006) and qualitative approaches (e.g., Lien et al., 2014), to understand the full dimension of how people interact with their environments.

According to Slaug et al. (2012), a number of factors may have contributed to the less than ideal levels of agreement attained. That is, there are many methodological challenges to analyzing inter-rater agreement using multiple pairs of raters and varying home environments. Percentage of agreement does not consider chance, while kappa is limited by its dependence on prevalence (Hallgren, 2012; Sim and Wright, 2005). Therefore, one possible explanation for low

kappa values across certain items may relate to the issue of prevalence. When prevalence of a certain item is low, two observers may reach a high percentage of agreement with simultaneously low values of kappa (Feinstein and Cicchetti, 1990; Hallgren, 2012). In line with the results of previous studies (Helle et al., 2010), the agreement results between the two modes of analysis and among the sub-sections of the environmental component are somewhat contradictory. Although the mean agreement levels were moderate, certain items had high percentages of agreement and lower kappa scores, while the result for others displayed the reverse situation. The lower kappa values and percentages of agreement for certain items within particular subsections warrant further consideration in further studies and upcoming projects.

It should also be kept in mind that the differences in housing stock between a limited region of the U.S. Pacific Northwest and other, more historic areas of the U.S. may have affected resultant prevalence and agreement estimates. As an example, the lowest kappa values were found in subsection B (entrances), and more specifically the items regarding elevators. While the percentages of agreement were all above 90%, the lack of an elevator in all but three of the 50 assessed home environments in this region shows that low kappa values are attributable to low prevalence and not to true threats to consistency between raters. Similar results were found in environmental items in subsection B related to ramps at entrances; very few homes in our sample had this feature. Therefore, while including such items is required for housing accessibility assessment on the individual level, the lack of some design features may skew kappa values in a negative direction when evaluating inter-rater agreement.

The results show a similar level of percentage of agreement between measurable and professional judgment items, although the kappa value was higher for the measurable items ($\kappa = 0.448$; moderate) than the professional judgment items ($\kappa = 0.361$; fair). The majority of

measurable items were assessed through specific measurable or observable standards (e.g., specified width of doorways, height of steps/thresholds, presence of discernible features), making them less open to interpretation than professional judgment items that require the subjective interpretations of raters (e.g., heaviness of doors). Thus, the differences between item types may have played a role for the facets of the results that demonstrate moderate levels of agreement.

Low agreement values between rater pairs may also be attributable to insufficient training of raters and/or basic human error. Reliable HE assessments are partially reliant on rater competence, but more so on appropriate, thorough, and consistent training and supervision (Helle et al., 2010). According to the instrument manual (Iwarsson and Slaug, 2010), a rater needs to accomplish approximately 25 assessments to attain the skills required for reliable data collection. Although raters were knowledgeable of accessibility guidelines, building codes, and housing design, they were relatively inexperienced with conducting assessments. The introductory training was study-specific and not a full training course, and therefore may not have been enough with respect to practice and specificity for this particular group.

Importantly, the personal component of the original HE (Iwarsson and Slaug, 2010) was not included in this study. While the personal component items are universal among human beings, terminology and assessment techniques are not. Therefore, before the U.S. HE can be fully implemented, similar training procedures and inter-rater agreement studies must be conducted on the personal component of the instrument. Once reliable instrument use is established for both the personal and environmental component across other U.S. contexts, the U.S. HE instrument can be used for standardized, objective assessments of accessibility problems within home environments in research and practice.

5. Conclusion

Establishing a reliable and valid U.S. HE version has important implications for future use in research and practice. Individually, practitioners can use this instrument to assess the magnitude of accessibility problems and identify environmental barriers that generate most problems, in order to determine appropriate home modifications that encourage the performance of daily activities. Nationally, U.S. policymakers, designers, planners, and public health professionals could determine population-level accessibility problems that assist in directing funding and programming, as well as creating appropriate policies and solutions on a national or community scale. In research, besides describing the housing situation for people with disabilities across the U.S., comparing cross-national accessibility problems on a global scale could contribute to greater worldwide empirical knowledge and understanding of accessibility and objective P-E fit in different population segments. However, in order to be able to fulfill such ambitions, additional methodological studies on the U.S version of the HE are needed.

Acknowledgements

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Table 1.

Items changed in the U.S. Housing Enabler (HE) compared with the current original HE
instrument (Iwarsson & Slaug, 2010) (N = 34)

Environmental Component Subsection	Environmental Barrier Item	U.S. HE version	Original HE version*
A. Exterior surroundings	A23. Insufficient maneuvering space at seating places	60" diameter or standard t-shaped space	1.5 m x 1.5 m
B. Entrances	B1. Narrow door openings at entrance	< 32"	84 cm
	B2. High thresholds/steps at entrance	> ½"	15 mm
	B3. Insufficient maneuvering space at doors	< 60" x 42", inside & out	1.5 m x 1.5 m
	B13. Stair treads w/ narrow or irregular depth	< 11"	26 cm
	B14. High, low, or irregular heights of risers	outside 4 – 7"	15 – 17 cm
	B18. Handrails too high/low	outside 34 – 38"	15 – 17 cm
	B22. Steep slopes	> 1:12	1:20
	B27. Wide gap between elevator/floor	max. 1 ¼"	3 cm
	B43. Narrow door to sitting out place	< 32"	84 cm
	B44. High threshold/step to sitting out place	> ½"	15 mm
	B46. Steep transition from one level to another	1:12	1:20
C. Indoor environment	C1. Stairs/thresholds/differences in level	> ½"	15 mm
	C3. Narrow passages—design of building	< 36"	1.3 m
	C4. Narrow doors	< 32"	76 cm
	C6. Insufficient maneuvering spaces where turning is necessary	< 60" x 60" turning circle	1.3 m x 1.3 m
	C11. Stair treads with narrow/irregular depth	< 11"	26 cm
	C12. High, low, or irregular height of risers	outside 4 – 7"	15 – 17 cm
	C15. Handrails too high/low	outside 34 – 38"	15 – 17 cm

Table 1. (continued)

C42. Kitchen/laundry controls too high	> 44"	1.1 m
C43. Kitchen/laundry controls too low	< 15"	80 cm
C44. Insufficient maneuvering spaces where turning is required in bathroom	< 60" x 60" turning circle	1.3 m x 1.3 m
C48. Grab bars in high position	> 36"	90 cm
C49. Grab bars in low position	< 33"	80 cm
C61. Bathroom controls too high	> 44"	1.1 m
C62. Bathroom controls too low	< 15"	80 cm
C63. Bathroom sink placed at height for use only when standing	top edge 34" or more above finish floor	81 cm
C64. Toilet lower than 17"	< 17"	47 cm
C66. Insufficient leg room under bathroom sink	clearance height < 27", depth < 19", width < 30"	60 cm, 80 cm
C67. Bathroom mirror at height only for use when standing	lower edge > 40" above finish floor	90 cm
C68. Toilet roll holder in inaccessible position	outside range of 7 – 9" from center, height other than 15 – 48"	0.9 – 1.2 m
C69. Bathroom storage cupboards, towel hooks, etc. placed high/low	outside range of 40 – 48"	0.9 – 1.2 m
C83. Other controls too high/inaccessible	> 44"	1.1 m
C84. Other controls too low	< 15"	80 cm

Note. U.S. HE item specifications based on DOJ, ANSI, ADA, FHA, & IBC accessibility guidelines. In many cases, guidelines among five sets of regulations were identical. In cases where they were not, decisions were made among the U.S. research team and further validated through collaboration with European counterparts. *Original HE version, Iwarsson and Slaug (2010).

Table 2.

Agreement for sub-section/type of environmental item in the U.S. Housing Enabler among 11 pairs of raters (N = 50 cases)

	Agreement Coefficient	
Environmental barrier subsection (n items)	Mean kappa	Mean percentage
A. Exterior surroundings (n = 28)	0.448	77
B. Entrances (n = 46)	0.389	86
C. Indoor environment (n = 87)	0.382	84
Measurable items (n = 70)	0.448	82
Professional judgment items (n = 91)	0.361	83
Total (n = 161)	0.410	82

Note. Kappa values 0.21 – 0.40 indicate fair agreement, 0.41 – 0.60 moderate agreement, 0.61 – 0.80 good agreement, and 0.81 – 1.0 very good agreement (Altman, 1999).

Table 3.

Agreement levels for the 161 environmental items in the U.S. Housing Enabler (N = 50 cases)

Agreement level	Total no. items	Subsection A: Exterior surroundings (n = 28)	Subsection B: Entrances (n = 46)	Subsection C: Indoor environment (n = 87)
Kappa				
Very good	3	0	1	2
Good	30	6	12	12
Moderate	42	11	9	22
Fair	54	10	11	33
Poor	32	1	13	18
Percentage				
≥ 80%	110	10	40	60
70 – 79%	34	11	4	19
< 70%	17	7	2	8

Note. Kappa values as interpreted by Altman (1999).