Older Adult-Centred Design

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ABSTRACT
A poorly designed home environment is likely to cause falling for older adults. By employing the concept of older adult-centred design, home design that reduces the risk of falls for older adults can be achieved. This approach focuses on meeting specific human needs and enabling individuals to experience improved functionality within the living space. This paper presents an evidence-based analysis of bathroom design from the perspective of reducing the risk of falling for older adults. The methodology is divided into three stages: (1) evidence-based review of bathroom design; (2) cohesive analysis of evidence-based studies; and (3) definition of best practice for older adult-centred design. The outcome of this paper is an evidence-based approach to older adult-centred design that is associated with the minimum risk of falling.

KEYWORDS
Older adults, Evidence-based, fall, adult-centred design, human-centred design

INTRODUCTION
In the next 25 years, the Canadian population of older adults aged 65 years and over is expected to double to approximately 10.4 million by 2036, forming one of the largest demographic waves in Canadian history. The safety of an aging population is an increasing concern that needs to be addressed. One in three older adults is expected to experience at least one fall per year in the home environment (Donald and Bulpitt 1999; Elliott et al. 2009; Gillespie et al. 2003; PHAC 2014; Scott et al. 2005). Most falls that take place in the home lead to injuries and hospitalization (PHAC 2014). In addition, 10% of these injures have been classified as serious injuries such as hip fractures and head injuries (O'Loughlin et al. 1993; Tinetti et al. 1995; Tinetti et al. 1988). Also, older adults who have experienced a fall are subject to develop social withdrawal, fear of falling, and activity restriction due to falling (Kannus et al. 2005; Nevitt et al. 1991; Rogers et al. 2004; Tinetti and Williams 1998; Vellas et al. 1997). Some home spaces, such as the bathroom, have been associated with a greater risk of falling for older adults (Devito et al. 1988; Nevitt et al. 1989). Evidence-based studies have reported difficulty for older adults to perform Activities of Daily Living (ADL); this refers to cases in which a simple task, such as standing up from the toilet or stepping out of the shower, found to be difficult for an older adult to perform (Aminzadeh et al. 2000; Buchman et al. 2014).

Human-centred design is an approach to meet human needs and enable individuals to better function within a given space. Lawton and Nahemow (1973) have presented a framework to model the reciprocal relationship between users, (in this case, older adults), and the environment (Lawton M. P. 1973). In the 1980s, the term *universal design* or *life span design* was used to refer to an approach to designing the built environment to function for different ages and abilities. Norman and Draper (1986) first introduced this user-centric design as a new practice through human computer integration (Norman and Draper 1986). Human-centric design has been acknowledged by International Organization for Standardization (ISO) 13407 (1999) standards as a process for system development. Human-centred design, in its most recent definition, includes optimizing the physical design of the surrounding environment in order to meet the needs and abilities of users. In 2012, three major design paradigms have been identified by Giacomin (2012): (1) technology-driven design that focuses on technology implementation; (2) sustainability-driven design that focuses on human ecological footprint and impact on the surrounding environment; and (3) human-centred design that focuses on satisfying human needs (Giacomin 2012).

This paper presents the concept of older adult-centred design. Designing a home for older adults associated with the minimum risk of falls can be achieved through the application of this concept, which is an approach branching from the concept of human-centred design in order to meet the needs of older adults as a specific group. The concept of older adult-centred design enables individuals to better function within various home spaces, such as the bathroom. This older adult-centred design concept is proposed through an evidence-based analysis that is implemented in bathroom design from the perspective of reducing the risk of falling for older adults. The methodology is divided into three stages: (1) evidence-based review of bathroom design; (2) cohesive analysis of collected evidence-based studies; and (3) definition of best practice for older adult-centred design (see Figure 1).

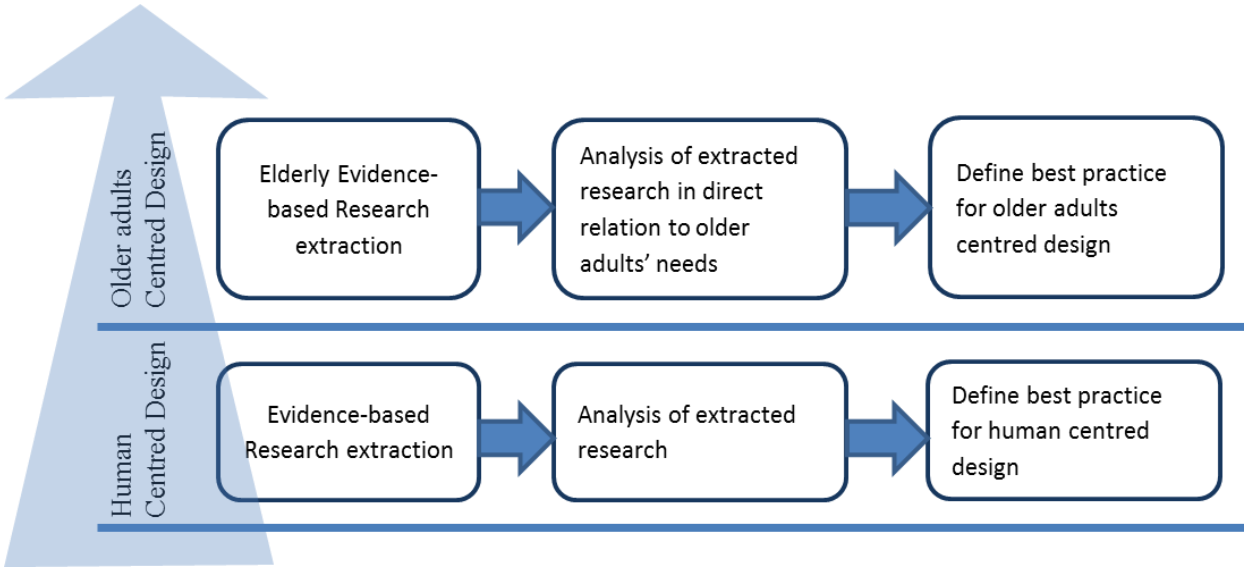

Figure 1. Research methodology for older adult-centred design in relation to human-centred design

The proposed research methodology represents a human-centred design implemented for a specific group of older adults, which can be broadened to include different groups of people sharing similar needs, such as children in schools, workers in factories, and patients in hospitals. Since the centre of all approaches is human need, the concept of human-centred design can be studied from multiple perspectives, such as ergonomics, physiology, and safety (Giacomin 2012). In this paper, older adults' safety in relation to risk of falling is the main concern.

BATHROOM DESIGN

The toilet and bathtub are two bathroom design elements featured in most home bathrooms (Aminzadeh et al. 2000; Parrott et al. 2013). This paper identifies evidence-based research with respect to these two bathroom design elements, with older adults being the center of the process as evidence-based papers are presented to satisfy older adults' group needs. Based on the analysis of evidence-based studies, best practice is formulated for older adult-centred design. This research adopts an evidence-based study analysis approach, based on applying the optimal available research results that is been extracted from evidence-based practice methods such as randomized control trials studies. This strategy is in line with the assertion of Youngblut (2001) study that evidence-based studies are likely to result in the most desirable outcome for users (Youngblut and Brooten 2001).

Bathroom Toilet Design

Toilet height needs to be adjusted to facilitate sit-to-stand activity for older adults. Clarke (1984) has shown that many older adults lack the ability to stand from a seated position (Clarke et al. 1984). Trying to stand from a seated position may cause a shift in center of mass, which can cause an older adult to fall (Campbell et al. 1989; Nevitt et al. 1989; Tinetti et al. 1986). Capezuti (2008) has found that toilet height needs to be 100% to 120% of the older adults' lower leg length in order to safely perform sit-to-stand action. In addition, some additional devices such as toilet grab-bars must be installed to facilitate both sitting down and standing up from the toilet (Sanford et al. 1995).

Based on Sanford's (1995) study, the optimal toilet grab-bar system requires two components: (A) one bar 1,220 mm in length, installed diagonally at a 45° angle, 500 mm distance from the end of the toilet; and (B) another bar 500 mm in length, installed horizontally, 300 mm distance from the end of the toilet (see Figure 2). The toilet grab-bar must have the appropriate surface texture (not too smooth and not too rough) in order to be safe for the grasping hand (Haslam and Stubbs 2006; Maki 1988; Templer 1992); a grab-bar that is too smooth or too rough may cause the grasping hand to slide, which can produce a sudden action of trying to re-grasp the grab-bar, thereby increasing the likelihood of a fall. Additionally, some falls may result from a larger or smaller diameter of the toilet grab-bar (Maki 1988). Maki (1988) identified the optimal grab-bar diameter to range from 32 mm to 51 mm.

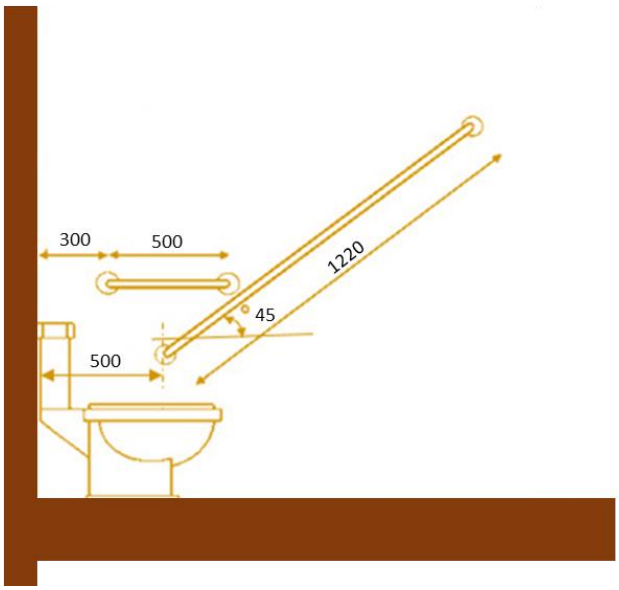

Figure 2. Toilet grab-bar optimal dimension (all dimensions in millimeters).

Bathtub design

In order to facilitate the movement of (1) getting in and out of the bathtub, and (2) getting up from and laying down in the bathtub, Sveistrup (2006) has examined different grab-bar sets. Based on this study, the optimal grab-bar set associated with the minimum risk of falling and with best facilitating getting in and out of the bathtub is illustrated in Figure 3: the bar is 1,200 mm in length, is vertically installed, and satisfies distance of 180 mm to 280 mm from the bottom of the grab-bar to the top of the tub rim (Sveistrup et al. 2006). As illustrated in Figure 4, the optimal grab-bar set associated with the minimum risk of falling and that best facilitates getting up from and laying down in the bathtub has been found by Sveistrup (2006) to be either: (A) 1,200 mm in length, horizontally installed within 180 mm to 280 mm distance from the top of the tub rim to the bottom of the grab-bar, and installed on the back wall of the bathtub; or (B) 600 mm in length, installed diagonally at a 45° angle on the back wall of the bathtub, and installed 300 mm distance from the side wall and 150 mm distance from the top of the bathtub rim.

Bathtub surface texture and diameter specifications should be, as with the toilet design specifications described above, not too rough and not too smooth, and the optimal diameter range is from 32 mm to 51sdddd mm (Maki 1988). Slippery bathtub floors, in addition to unfixed bathroom mats, have been associated with a high risk of falling for older adults (Clemson and Martin 1996; Sveistrup et al. 2006). Therefore, the optimal scenario for safe gait movement within the bathtub is to have a non-slip bathtub floor surface with a well fixed non-slip bathtub mat, if existed (Clemson and Martin 1996; Sveistrup et al. 2006).

Figure 3. Optimal bathtub grab-bar configuration for side wall installation (all dimensions in millimetres).

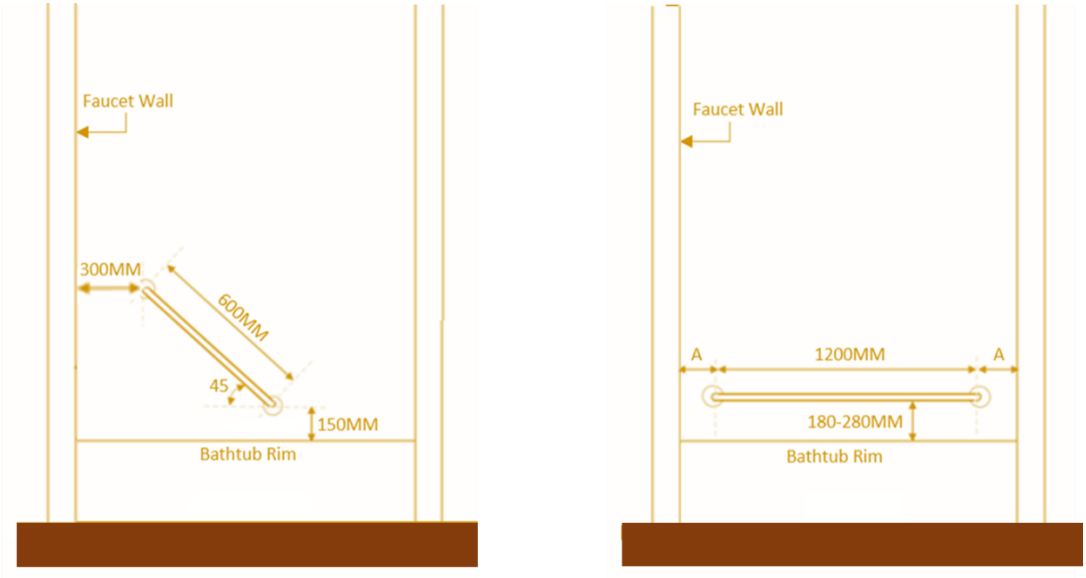

Figure 4. Optimal bathtub grab-bar configuration for back wall installation.

CONCLUSION

The concept of older adult-centred design is proposed in this paper through an evidence-based analysis that is implemented in bathroom design, as an example of a home space, and from the perspective of reducing the risk of falling for older adults. The authors believe in multi-disciplinary approach to address factors in relation to falls, such as optimal home environmental design to reduce the risk of falling for older adults. This paper proposes a framework to improve the home environment with older adults being the center of the process. This concept is implemented through selecting evidence-based studies that is developed for older adults participants aged 65 years and

over. With a focus on older adults being the center of process, best practice for older adults that is associated with the minimum risk reduction is proposed in this research, which identifies an implemented methodology to older adult- centered design.

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