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Who are the Older Adults Who Drown in Western Australia? A Cluster Analysis Using Coronial Drowning Data.

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Cover Page Footnote

We would like to acknowledge those listed in the coronial dataset; and pay our respects to their loved ones, families and friends. We would also like to acknowledge the Royal Life Saving Society of Western Australia for their contributions. Declaration of Conflicting Interests The authors declared no potential conflicts of interests with respect to the authorship and/or publication of this article.

Abstract

Drowning amongst older people is a growing concern. Exploring demographic and other factors associated with unintentional drowning incidents amongst older adults may assist to identify key target groups and refine prevention strategies. This study sought to examine the heterogeneity of older individuals who have drowned and identify population subgroups in Western Australia (WA). A cluster analysis was used to segment the population by examining coronial data 2001-2018 (n = 93). Analysis identified four groups; 1) 'men who boat & fish in company' 2) 'affluent men with poor health' 3) 'non-drinkers who boat and fish', and 4) 'older men, who slipped or fell'. Males aged 65-74 years were particularly at-risk while participating in various aquatic activities such as boating, fishing (incl. rock-fishing) and swimming/recreating. This study provided insights into an underserved area and will directly inform the development of new strategies for this target group in WA.

Keywords: drowning prevention, water safety, cluster analysis, coronial data, public health, older adults.

Introduction

Drowning is the third leading cause of unintentional death worldwide (World Health Organization [WHO], 2017). In Australia, as in a number of other high-income countries (Armstrong & Erskine, 2018; Lin et al., 2015; Mahony et al., 2017), drowning amongst older people is an ongoing problem and the rate of drowning among older people is likely to rise as Australia's ageing population increases (Peden et al., 2018). Between 2017/18 and 2018/19 drowning in older Australians increased from 51 fatalities to 60 fatalities respectively, an 18% increase (Royal Life Saving Society - Australia [RLSSA], 2019a). In countries such as Australia, aquatic activities are common amongst older people for recreation and physical activity (Mahony et al., 2017; RLSSA, 2019a). For example, swimming is the fourth most common form of sport and/or physical recreation in people aged 65 years and over (Mahony et al., 2017) and recreational fishing, diving, surf sports and boating are identified among the top 20 physical recreation activities in Western Australia (Australian Bureau of Statistics [ABS], 2012). Noteworthy, an increased exposure to risk is reflected in a greater level of participation in aquatic activities such as swimming, fishing, surfing, boating, and canoeing/kayaking (Leavy et al., 2015), along with seeking a "sea-change", where moving closer to coastal locations during retirement is common (Peden et al., 2018).

Despite the benefits of aquatic activity to enhance the quality of life of older people, little is known about factors relating to drowning prevention and water safety for this age group (Mahony et al., 2017; Peden et al., 2018). Historically, the focus of international drowning literature has been on drowning in children aged under 5 years (Leavy et al., 2015; Peden et al., 2018). There is a dearth of drowning prevention literature specific to older adults. While the literature

provides some insights into the epidemiology and risks for older people (Peden et al., 2018), gaps in the knowledge remain (Mahony et al., 2017). Franklin, Scarr and Pearn (2010) highlight overestimation of ability and reliance on skills gained earlier in life, reduced fitness and physical limitations brought on by age and medical conditions as risk factors contributing to drownings amongst older people. Despite this, a more in-depth demographic profile is needed to determine how and why older adults drown and appropriately target at-risk individuals in this age group.

This study sought to examine the heterogeneity of risk and/or protective factors amongst older adults who have drowned in one Australian jurisdiction and identify population subgroups. The consensus for 'older adults' differs per country, with definitions ranging between 45-75 years (Peden et al., 2018). Throughout this study, 'older adults' is used to describe people 65 years and older, as defined in the National Australian Water Safety Strategy 2016-2020. Findings will have direct impact on the development of health promotion strategies and interventions to prevent older adults drowning.

Method

Cases and Procedures

Coronial data were obtained using the National Coronial Information System (NCIS). Ethical approval was obtained from the University Human Research Ethics Committee (HRE2019-0347) and the Justice Human Research Ethics Committee (CF/16/17315). All coronial data were de-identified.

The data consisted of the 95 fatal drowning cases recorded between the period, July 2001–June 2018. Each case contained a coroner's investigation and pathology report. Additional information, such as swimming ability and supervision status, was extracted from witness statements and police reports following the incident. Cultural and linguistic diversity (CaLD) was assessed using data detailing country of birth, and years in Australia. In this study, tourist status was categorised as international (overseas), interstate (between states), within state (between regions), and within region (more than 100km from local residence i.e. travelled between towns). Missing information was indicated as 'unknown'. Two cases were removed because they were either intentional drownings or occupational incidents (these cases go beyond the scope of recreational drowning prevention and are not the current focus for this study or the peak drowning prevention organisation in WA). All available variables are listed as a supplementary file. Predictor variables (variables used in the final analyses) were initially identified as 'important' after a review of the current literature (Franklin et al., 2010; Lin et al., 2014; Mahony et al., 2017; Peden et al., 2018; WHO, 2014) (by lead researcher [MA]). The WHO (2014) has reported alcohol use, prior medical conditions, and participating in aquatic activities alone as risk factors for drowning. Location (body of water), activities performed prior, and entry into water have been identified as critical factors in

understanding why and how older adults drown (Peden et al., 2018; Lin et al., 2014). Expert discussion was held between the research team (three drowning prevention researchers and a drowning prevention practitioner) who reached consensus on the predictor variables used in the final analyses. Variables selected for clustering were clinically and demographically relevant and thus considered the most appropriate predictor variables.

Data Analysis

Initially, bivariate analyses were conducted using chi-square tests of association between the demographic, clinical and drowning-specific variables (all variables were categorical) (Schaffer et al., 2014). Next, a two-step cluster analysis was conducted to determine if individuals (or other factors related to the drowning event) shared similar characteristics, specifically, whether there were statistically reliable sub-groups within the coronial data (Yip et al., 2009). This form of analysis was exploratory and used statistical distance algorithms to measure dissimilarity (Tkaczynski, 2017).

Demographic variables including age, sex and socio-economic status (SES) (the Socio-Economic Index for Area [SEIFA] disadvantage was used to group individuals into tertiles [low; medium; or high]) were selected to profile cases (ABS, 2018). SEIFA disadvantage is a score that ranks areas in Australia according to relative socio-economic disadvantage (ABS, 2018). The predictor variables retained in the final cluster analysis were: age, sex, SES ranking, swimming ability, tourist status, entry into water, activity performed prior to drowning, location type, and whether or not alcohol, a medical condition or the fact individuals were alone (or not) contributed to the drowning incident (contributing factors were identified by the coroner and coded into dummy variables for analysis, e.g. medical condition contributing; yes/no [see supplementary file]). Swimming ability was extracted from witness statements and police reports. In cases where swimming ability was not highlighted the individual's ability was classified as 'unknown'. The two-step cluster analysis identified differences in 'predictor importance' (Tkaczynski, 2017) and the relative importance of each variable in the estimating model (IBM Knowledge Center, 2012). Each cluster had a unique hierarchy of predictor variables that were most important for the cluster formation (Schaffer et al., 2014). The cluster criterion Akaike Information Criterion (AIC) (Bozdogan, 1994) and Log-likelihood were selected for use in this study because the number of clusters was 'determined automatically' and was validated using the AIC measure of model fit (Green et al., 2016; Yip et al., 2009) which is appropriate for finding the best approximating model (Bozdogan, 1994). The best model for cluster quality and measure of fit, 'the silhouette measure of cohesion and separation', resulted in four clusters, where the largest cluster was 1.3 times bigger than the smallest cluster (Rousseeuw, 1987). This silhouette measure demonstrates how well a case fits into the cluster (cohesion) to which it is assigned when compared to other clusters (separation) (Norusis, 2011). Based on these parameters, four

clusters were considered most ideal for this study. Analyses were conducted using SPSS version 26 (International Business Machines Corporation, 2017).

Results

The demographic characteristics of the individuals in the coronial dataset (n = 93) are shown in Table 1. Males were over-represented (86%) and two fifths (41%) of the individuals were aged 65–70 years. SES was well distributed. Half of the individuals were overseas born (51%); the majority were not tourists (72%).

The composition of each cluster is displayed in Table 2. Cluster One, the largest cluster, was 'men who boat & fish in company' (n = 26). Those in this cluster were predominantly 65–74 years of age (62%), mid-SES (54%), and almost two-thirds were not tourists (62%). Individuals in Cluster One were fishing and/or boating (42.3%) with others (90%) at the time of death. More than one-quarter (26.9%) had consumed alcohol while participating in aquatic activities. None of the individuals in Cluster One had a medical condition that contributed to the drowning incident.

Cluster Two was composed of 'affluent men with poor health' (n = 25). Men in this cluster were high SES (60%), local (84%), Australian residents (84%), between the ages of 65 and 74 years (72%). The majority of incidents in this cluster occurred at a beach, in the ocean or a harbour (64%) while individuals were swimming and/or recreating (100%). A high proportion of individuals in this cluster were identified as good swimmers (64%) however, for many their medical condition contributed to the incident (86%).

Cluster Three were 'non-drinkers who boat & fish' (n=20) and were aged 65–74 years (70%). A majority were low SES (65%) and large number of individuals in this cluster (45%) were tourists (those who were not local). None of them had alcohol recorded in their system. Individuals were often in company (81%) when the incident occurred. For individuals in this cluster, fishing (42%) was the most common activity performed prior to drowning and incidents occurred at a beach, in the ocean, or a harbour (85%). A large proportion of these individuals had a medical condition which contributed to drowning (75%).

'Older men who slipped or fell' comprised Cluster Four. This group consisted of men aged 75–84 years (67%), mid-SES (57%), who were not tourists (91%). Just under a third had a recorded alcohol presence and a majority had a prior medical condition that contributed to the incident (75%). These individuals were usually recreating (81%) around a pool (home or other) (48%) and slipped or fell into the water (91%).

Table 1

Demographic characteristics

Characteristic	**% (n = 93)**
Sex	
Male	86.0 (80)
Female	14.0 (13)
Age (years)	
65–70	40.9 (38)
71–75	21.5 (20)
76–80	22.6 (21)
81–84	11.8 (11)
85+	3.2 (3)
Country of birth	
Australia	45.2 (42)
Other	50.5 (47)
Unknown	4.3 (4)
Socio-economic status (SES)	
Low	28.0 (26)
Mid	37.6 (35)
High	34.4 (32)
Tourist Status	**% (n = 92)**
Not a tourist	72.0 (67)
International	8.6 (8)
Interstate	2.2 (2)
Within state visitor	10.8 (10)
Within region visitor	5.4 (5)

Table 2
The percentage values of the predictor variables by clusters

Cluster Number	**1 Men who boat & fish in company**	**2 Affluent men with poor health**	**3 Non-drinkers who boat & fish**	**4 Older men who slipped or fell**
Cluster Size*	**28.3% (n=26)**	**27.2% (25)**	**21.7% (20)**	**22.8% (21)**
Age				
65–74	61.5 (16)	72.0 (18)	70.0 (14)	23.8 (5)
75–84	38.5 (10)	20.0 (5)	30.0 (6)	66.7 (14)
85+	0.0 (0)	8.0 (2)	0.0 (0)	9.5 (2)
SES ranking				
Low	26.9 (7)	16.0 (4)	65.0 (13)	9.5 (2)
Mid	53.8 (14)	24.0 (6)	15.0 (3)	57.1 (12)
High	19.3 (5)	60.0 (15)	20.0 (4)	33.3 (7)
Tourist Status				
Not a tourist	61.5 (16)	84.0 (21)	55.0 (11)	90.5 (19)
International	3.8 (1)	4.0 (1)	20.0 (4)	9.5 (2)
Interstate	0.0 (0)	4.0 (1)	5.0 (1)	0.0 (0)
Within state	15.4 (4)	8.0 (2)	15.0 (3)	0.0 (0)
Within region	15.4 (4)	0.0 (0)	5.0 (1)	0.0 (0)
N/A	3.8 (1)	0.0 (0)	0.0 (0)	0.0 (0)
Drowning event location				
Lake/dam/lagoon	11.5 (3)	0.0 (0)	0.0 (0)	19.0 (4)
Beach/Ocean/Harbour	73.1 (19)	64.0 (16)	85.0 (17)	4.8 (1)
Pool (Home & other)	3.8 (1)	32.0 (8)	0.0 (0)	47.6 (10)
River/Creek/Stream	7.7 (2)	4.0 (1)	15.0 (3)	23.8 (5)
Other	3.8 (1)	0.0 (0)	0.0 (0)	4.8 (1)

Entry into the water				
Unintentional – slip or fell	7.7 (5)	0.0 (0)	20.0 (4)	90.5 (19)
Unintentional boating/fishing & rock fishing	42.3 (11)	0.0 (0)	55.0 (11)	0.0 (0)
Unintentional – submerged vehicle	15.4 (4)	0.0 (0)	0.0 (0)	0.0 (0)
Intentional (e.g. swimming/recreating)	12.5 (3)	100.0 (25)	25.0 (5)	0.0 (0)
Unknown – Intentional/Unintentional	12.5 (3)	0.0 (0)	0.0 (0)	9.5 (2)
Activity[1]				
Swimming & Recreating	15.4 (4)	96.0 (24)	15.0 (3)	80.9 (17)
Fishing (incl. boating)	42.3 (11)	4.0 (1)	60.0 (12)	4.8 (1)
Boating/watercrafts (e.g. surfing/kitesurfing)	26.9 (7)	0.0 (0)	25.0 (5)	4.8 (1)
Other	15.4 (4)	0.0 (0)	0.0 (0)	9.5 (2)
Alcohol presence				
Yes	26.9 (7)	16.0 (4)	0.0 (0)	28.6 (6)
No	57.7 (15)	84.0 (21)	95.0 (19)	66.7 (14)
N/A	15.4 (4)	0.0 (0)	5.0 (1)	4.8 (1)
Swimming ability				
Good swimmer	11.5 (3)	64.0 (16)	40.0 (8)	4.8 (1)
Average swimmer	3.8 (1)	20.0 (5)	0.0 (0)	9.5 (2)
Poor swimmer	3.8 (1)	4.0 (1)	15.0 (3)	0.0 (0)
Non-swimmer	7.7 (2)	8.0 (2)	0.0 (0)	23.8 (5)
Unknown	73.1 (19)	4.0 (1)	45.0 (9)	61.9 (13)

Medical condition[2]				
Yes	0.0 (0)	92.0 (23)	75.0 (15)	85.7 (18)
No	100.0 (26)	8.0 (2)	25.0 (5)	14.3 (3)
Alone[3]				
Yes	19.2 (5)	40.0 (10)	10.0 (2)	19.0 (4)
No	80.8 (21)	60.0 (15)	90.0 (18)	81.0 (17)

[1] Activity performed prior to the drowning

[2] Medical condition contributing to the death

[3] Individuals were alone during the incident

***n = 92 – one individual was not assigned into a cluster** (this case was an outlier and did not fit into any of the four clusters)

Discussion

This study sought to examine the heterogeneity of risk and/or protective factors amongst older adults (aged 65 and older) who have drowned in one Australian jurisdiction through an examination of coronial data. To the best of our knowledge, no previous studies have segmented coronial drowning data to construct a detailed demographic profile of older adults who have drowned for target audience segmentation. The analysis identified four profiles of people who had drowned: 1) ‘Men who boat and fish in company’; 2) ‘Affluent men with poor health’; 3) ‘Non-drinkers who boat & fish’; and 4) 'Older men, who slipped or fell’.

Findings of this study are consistent with those of previous research that has identified males of all ages at increased risk of drowning in many countries (WHO, 2014; WHO, 2017). Results correspond with Australian data that suggest older males are at greater risk than older females (RLSSA, 2019a), and both national and international data which indicates that drownings are more prevalent in the younger years of this age group e.g. 65-74 (Lunetta et al., 2004; Pearn et al., 2018; Queiroga, 2013). The cluster analysis findings are consistent with the drowning risk factors identified in the current literature. Sex; age; pre-existing medical condition; alcohol presence; visitor status; location (ocean/harbour); and activities performed prior (swimming & recreating, boating) have been identified as known risk factors for drowning in older adults (Mahony et al, 2017; RLSSA, 2019a). While there have been a couple of Australian drowning prevention interventions focused on older adults (the Grey Medallion programme and ‘the talk’ campaign) (RLSSA, 2019b; RLSSA, 2020), it is not clear whether these programs have reduced drowning deaths among older adults as often drowning prevention programs have not been formally evaluated. The study findings will provide the formal basis for future programs in an Australian setting.

Implications and Opportunities for Research, Policy and Practice

The findings from this study highlight the complexities of developing effective strategies for drowning prevention amongst this age group. Consequently, the study has generated considerations for future policy, practice, and research. Research opportunities include further exploration of the knowledge, attitudes, beliefs & behaviours of water safety in older people, including those living in regional and rural/remote locations (Queiroga & Peden, 2013). Examining behaviour and location as risk factors is recommended including increased aquatic participation and travel patterns after retirement (Pearn et al., 2019). Further research that influences policy and practice will support the achievement of key targets in the Australian Water Safety Strategy (AWSS) (2016) and beyond. Given that study findings provide several profiles of those who drown, future practice should aim to 1) create, implement and evaluate public awareness campaigns that seek to reduce drowning in people aged 65

years and over (Peden et al., 2018); 2) strengthen drowning prevention and aquatic programs designed for the ageing population (World Health Organization, 2017); and 3) increase cross-sector partnerships with falls prevention and other health ageing sectors. These key recommendations directly align with the AWSS (Australian Water Safety Council, 2016).

Strengths and Limitations

This is the first study to use a cluster analysis to address drowning in older adults. Findings have provided a detailed profile of older adults who have drowned in Western Australia, a strength of the study. The researchers worked collaboratively with the key drowning prevention organisation, an important step in the development of evidence-informed strategies that are practical for end users; bridging the gap between research and decision-making. This was an exploratory study which provided a foundation for more informed campaign development and areas for further research.

Several limitations have been identified. The sample size was small, though it was the complete dataset of drownings for older adults in Western Australia. Cluster analysis results depend on the choice of variables used in analysis and cluster analysis cannot identify causation (Huntington et al, 2008; Tkaczynski, 2017). However, this analysis identified homogenous clusters where grouping had not previously been known and provides distinct profiles for future campaign design (Green et al., 2016; Tkaczynski, 2017). Two-step cluster analyses have previously been criticised for being 'overly descriptive' and therefore may result in solutions that are unable to predict behaviour, however, the data has been used to identify meaningful segments. While the NCIS provides in-depth detail for some cases, several cases in this study had missing information for swimming ability, entry into water and bystander information/accounts. Medical condition was coded as a dummy variable (binary; yes or no) and only indicated whether a medical condition(s) was contributory or not, future research might consider a more in-depth exploration of specific medical conditions. Future research might explore bystander age to understand their ability to assist with a rescue. Noteworthy, swimming ability was extracted from witness statements and police reports and may not be an accurate depiction of true ability. The cluster analysis data captured incidents in one jurisdiction only, though this allowed an in-depth exploration which has replication potential.

Conclusion

This research set out to address a real-world concern for public health; drowning amongst adults aged 65 years and older in an Australian jurisdiction by examining the heterogeneity of risk and/or protective factors for drowning in older adults (aged 65 and older) through the examination of coronial data. This study provided new insights into an underserved area and will directly inform the development of new strategies and interventions for this target group.

Drowning is a largely preventable but neglected public health issue. This study contributes to the sparse body of literature that addresses drowning prevention amongst older adults.

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