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Review

Epidemiology, Risk Factors and Measures for Preventing Drowning in Africa: A Systematic Review

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Abstract: *Background*: Drowning is a leading cause of unintentional injury related mortality worldwide, and accounts for roughly 320,000 deaths yearly. Over 90% of these deaths occur in low- and middle-income countries with inadequate prevention measures. The highest rates of drowning are observed in Africa. The aim of this review is to describe the epidemiology of drowning and identify the risk factors and strategies for prevention of drowning in Africa. *Methods*: A review of multiple databases (MEDLINE, CINAHL, PsycINFO, Scopus and Emcare) was conducted from inception of the databases to the 1st of April 2019 to identify studies investigating drowning in Africa. The preferred reporting items for systematic review and meta-analysis (PRISMA) was utilised. *Results*: Forty-two articles from 15 countries were included. Twelve articles explored drowning, while in 30 articles, drowning was reported as part of a wider study. The data sources were coronial, central registry, hospital record, sea rescue and self-generated data. Measures used to describe drowning were proportions and rates. There was a huge variation in the proportion and incidence rate of drowning reported by the studies included in the review. The potential risk factors for drowning included young age, male gender, ethnicity, alcohol, access to bodies of water, age and carrying capacity of the boat, weather and summer season. No study evaluated prevention strategies, however, strategies proposed were education, increased supervision and community awareness. *Conclusions:* There is a need to address the high rate of drowning in Africa. Good epidemiological studies across all African countries are needed to describe the patterns of drowning and understand risk factors. Further research is needed to investigate the risk factors and to evaluate prevention strategies.

Keywords: drowning; immersion injuries; Africa

1. Introduction

The World Health Organization (WHO) defines drowning as "the process of experiencing respiratory impairment from either immersion or submersion in liquid" [1]. Drowning is the third leading cause of unintentional injury related cause of mortality worldwide, accounting for 7% of all injury related deaths. It is a global under recognized and neglected public health burden that claims the lives of 320,000 people every year [2]. More than 90% of these deaths occur in low- and middle-income countries with inadequate prevention measures [3]. It is among the ten leading causes of deaths in children and young people in the world with children aged less than five years at increased risk [4]. Between 1990 and 2013, drowning rates declined by 52.2% globally [5], however, despite this decline, the highest rates of drowning were observed in Africa [3].

The African continent is unfortunately plagued with the world's most dramatic public health crises with communicable diseases such as HIV/AIDS, malaria, and lower respiratory tract infections as leading causes of death in the region [6]. In addition, there is an increasing burden of non-communicable (hypertension, diabetes and heart) diseases and injuries [6]. The combined burden of both the communicable, non-communicable diseases and injuries have placed a strain on the already weak health systems in addition to struggling economies in the continent [6]. In spite of injuries been identified as a leading cause of death in Africa [4], this public health threat is yet to receive the desired attention, rather the management and prevention of communicable diseases is still a top priority [6].

Africa has recorded considerable success in reducing childhood deaths related to communicable diseases [6]. However, there is limited statistics and data on drowning related deaths which also contributes to infant mortality rates. Age is a leading risk factor for drowning and commonly occurs among children aged 1–4 years [4]. A recent incident that occurred in a West African country, was the case of a thirteen-month-old child who drowned in his parents' indoor swimming pool [7]. This is a common occurrence in low- and middle-income countries (LMICs) and within the region [8]. Unfortunately, unlike high-income countries such as Australia and the United States of America (USA), drowning cases and deaths are under-reported in the African continent [4]. Other risk factors of drowning include, male gender, increased access to water, flooding disasters, commuting on water, lack of supervision and recreational drug use [4,9,10].

The knowledge of the epidemiology and risk factors of drowning aids the development and implementation of policies and strategies that reduce the incidence of drowning. Studies originating from high-income countries like Australia and USA suggest a range of primary and secondary prevention strategies to curb drowning deaths [11–15]. Recommendations proposed include increasing supervision, erecting pool fences, increasing public awareness and education through health promotion and public health advocacy [11–15]. However, these interventions may not be applicable in a region like Africa due to the diversity and variation in the epidemiologic, demographic and cultural factors [8].

Currently, there is no systematic review investigating drowning in Africa. Only three recent reviews on drowning in low- and middle-income countries, drowning in South Africa and Tanzania respectively have been published [8,16,17]. Therefore, it is imperative to understand the epidemiology, risk factors and current prevention strategies in Africa to direct policies for the prevention of drowning in Africa. Hence, the aim of this systematic review was to describe the epidemiology of drowning in Africa and to identify the risk factors and proposed and current strategies to prevent drowning.

2. Methods

2.1. Literature Search

The systematic review was conducted in accordance to the preferred reporting items for systematic review and meta-analysis guidelines (PRISMA) [18]. The PRISMA flow chart for the review is shown in Supplementary Figure S1. A literature search was conducted using Ovid Medline, Emcare, Cumulative Index to Nursing and Allied Health (CINAHL), PsycINFO, and Scopus for original research articles published in English from inception until the 30th of November 2018. The search was updated on the 1st April 2019. We included all articles focusing on drowning in Africa. There were slight variations in the search terms depending on the database. Search terms involved a combination of free text words and Medical Subject Headings (MeSH) terms. General search terms were "drown*" and "Africa". The search strategy for Medline is shown in Supplementary Table S1. The study protocol was registered in PROSPERO with registration number CRD42019092758.

2.2. Eligibility Criteria

The studies included in this review are published original research reporting drowning in African countries. We applied no limits to the year of publication and included all age groups. In addition, we included studies that reported drowning as part of other injuries studies to capture all data from the region. Studies excluded were review articles, drowning because of suicide or homicide, non-fatal drowning or near drowning or hospitalization due to drowning or where fatal drowning could not be distinguished from non-fatal drowning.

2.3. Data Extraction

Faith O. Alele (F.O.A.) and Theophilus I. Emeto (T.I.E.) identified all included studies from the search strategy. Uncertainties about the included studies was discussed until consensus was reached. FOA and TIE extracted general and study specific characteristics from the included studies and Lauren Miller (L.M.) and Richard C. Franklin (R.C.F.) crosschecked the data.

2.4. Quality of Methods Assessment

The methodological quality of the included studies was assessed by FOA and TIE using the modified quality assessment tool for studies with diverse designs (QATSDD) critical appraisal tool [19]. The tool assesses the validity, reliability and generalizability of studies. The included studies were a mix of cross-sectional, descriptive and case-control studies and each study design were assessed using the appraisal tool. The tool was modified to exclude two items that were not applicable to the included studies. The excluded items comprised of statistical assessment of reliability and validity of measurement tool(s) (Quantitative only), fit between stated research question and format and content of data collection tool e.g., interview schedule (Qualitative), assessment of reliability of analytical process (Qualitative only) and evidence of user involvement in design. In the modified QATSDD tool each criterion was awarded a score of 0 to 3 with 0 = not at all, 1 = very slightly, 2 = moderately and 3 = complete. The scores of the criteria were summed up to assess the methodological quality of included studies with a maximum score of 36. For ease of interpretation, the scores were converted to percentages and were categorised as excellent (>80%), good (50–80%) and low (<50%) quality of evidence based on the overall score (Supplementary Table S2).

2.5. Data Synthesis

Drowning was reported exclusively or as part of a wider study such as injury studies. Approximately 28% (11) of the included studies reported drowning as unintentional. In studies where drowning was unspecified, we reported the drowning as intentional. Measures used to report drowning were proportions and incidence rates. The incidence rates and proportions of drowning were reported using frequency tables. The risk factors for drowning were identified in two articles, one of which only reported drowning as part of a wider study. Therefore, the risk factors identified were extrapolated to drowning. However, given the paucity of information on risk factors associated with drowning, we identified the potential risk factors based on previously identified factors documented in the literature [3,4,8] and based on the reported rates of the potential factors. A meta-analysis was not conducted due to the heterogeneity of the included studies.

3. Results

3.1. Epidemiology of Drowning in Africa

The included studies were conducted across 15 countries in Africa (Figure 1). The databases searches identified 345 articles, of which 42 articles were included in the review after screening for titles, abstracts and full text review (Supplementary Figure S1). Three (3) studies reported drowning in multiple sites (countries) [20–22]. Twenty-four (57%) of the articles originated from South Africa [20–43], three (7.1%) were from Ethiopia [20,44,45], Ghana [20,46,47], Malawi [20,48,49], Nigeria [50–52] and Uganda [53–55] respectively, while 2 (4.8%) studies were from Cote d'Ivoire [20,56], Kenya

[20,57] and Egypt [21,22] respectively. One (2.4%) article each originated from Burkina Faso [20], Guinea [58], The Gambia [20], Tanzania [59], Seychelles [60] and Zimbabwe [61], See Figure 1 for location. The most commonly used data were surveillance data (46%) and death registers including hospital, police and coronial reports. Twelve (12) studies investigated and described drowning exclusively [21–27,30,43,50,54,60], while in 30 studies, drowning was reported as part of a wider study including studies investigation all cause of death and external causes of death [20,28,29,31–42,44–49,51–53,55–59,61]. Measures used to describe drowning were proportions and rates. Drowning rates in children were reported in thirteen (13) studies [21,28,30,31,33,35,37–39,42,46,49,52], while 29 (69%) studies described drowning rates of adults and children or adults alone [20,22–27,29,32,34,36,40,41,43–45,47,48,50,51,53–61]. The denominators used varied by country. In some studies, the estimated proportion or rate of drowning was based on the total population in the study area. By contrast, other studies reported the mortality rates for external causes and all cause of deaths. All deaths due to injuries, trauma and external causes were considered as mortality due to external causes using the ICD 11 classification [62].

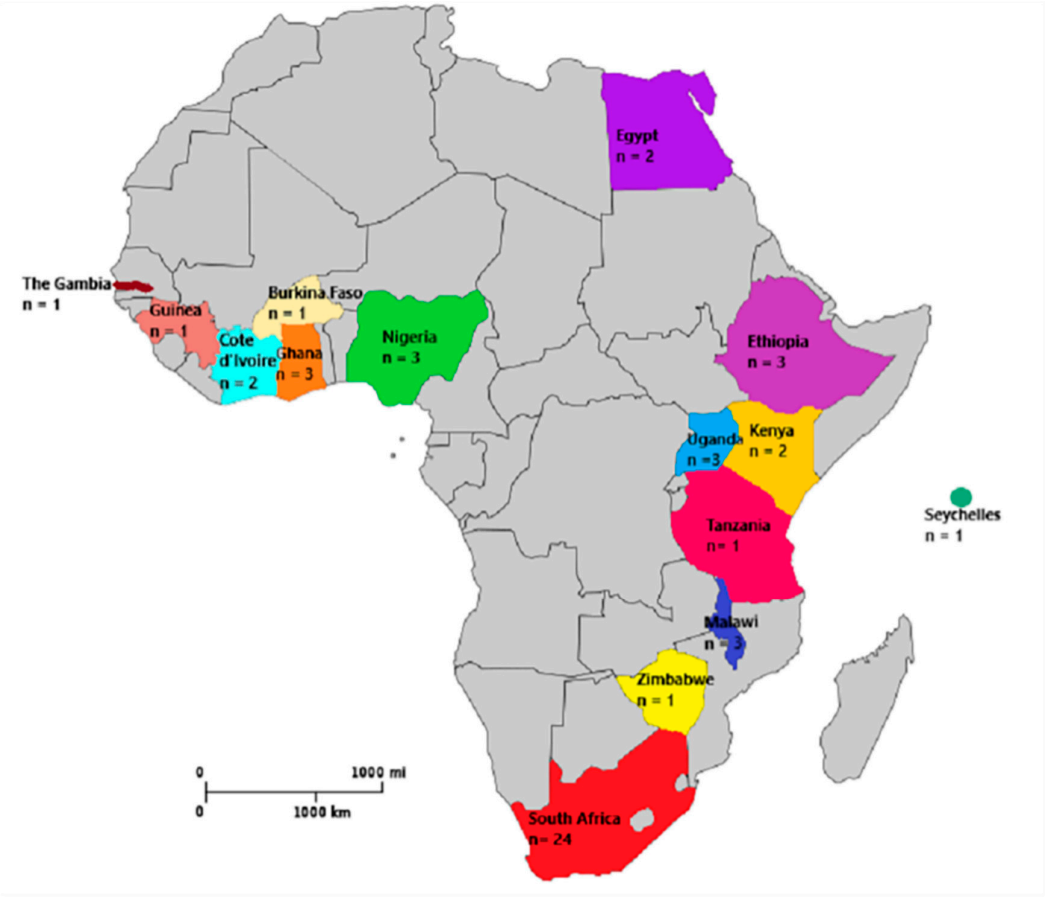

Figure 1. Map of Africa showing the countries and number of studies originating from each country was modified from Wikimedia Commons [63].

3.2. Drowning Rates in Africa

In Table 1, twelve (12) investigated drowning exclusively in different regions of Africa [21–27,30,43,50,54,60]. However, there were variable methods of reporting drowning across the different studies. Among population-based studies, the proportion of drowning fatalities ranged from 0.019% to 1.2% [23,26]. In studies where all submersion events were reported, unintentional drowning accounted for 80% of drowning deaths in one study [50], while accidental drowning accounted for 10.7% of all submersion (near drowning and drowning) events in another study [30].

The incidence rates of drowning across the different studies ranged from a low of 0.33/100,000 population to a high of 502/100,000 population [21,22,24,25,27,43,54]. However, the denominators for each study varied. Two studies were conducted using the total population in the country as the denominator [21,22], five studies were conducted within specific cities and towns and total population of the cities were used as denominators [23,24,27,43,54], while one study investigated drowning across five cities [25].

Of the 30 studies reporting drowning as part of a wider study (Table 2), 25 studies reported drowning as part of external cause of death (injury) [20,28,29,31–36,40–42,44–49,51–53,55,57–59], while 5 studies investigated all causes of deaths and reported the rates of drowning [37–39,45,56]. The studies investigating external causes of deaths reported drowning deaths either as a proportion [28,29,31–34,40–42,44,46,47,49,51,52,55,57,61] or as a rate [20,35,36,48,53,58,59] of all external causes of deaths. The proportion of drowning deaths as part of external causes of death ranged from 0.2% to 75% [28,29,31–34,40–42,44,46,47,49,51,52,55,57,61] while the incidence rate ranged from 2.1/100,000 to 10.2/100,000 [35,36,48,58,59]. One ecological study which investigated external causes of deaths across eight (8) countries reported drowning rates ranging from 0/1000 person years to 0.48/1000 person years [20], while. Lett et al., reported that drowning rate account for 0.1/1000 people of all external cause of deaths [53]. In studies reporting drowning as a part of all causes of deaths, the proportion of drowning deaths ranged from 0.02% to 11% [37–39,45,56].

In terms of drowning rates by age demographics, the proportion of drowning among children and adolescents ranged from 2.5% to 19% [28,30,31,33,37–39,42,46,49,52], while the incidence of drowning ranged from 0.33 to 5.3 per 100,000 population [21,35]. The rates of drowning among adults ranged from 0.33 to 502 per 100,000 population [22,24,25,27,36,48,54,59] and from 0 to 0.07 per 1000 person years [20,53]. In addition, the proportion of drowning among adults ranged from 0.019% to 80% [23,26,29,32,34,40,41,44,45,50,51,55–58,60,61].

Table 1. Summary of studies exclusively reporting drowning in Africa.

Authors, Reference, Year	Country	Study Design	Year	Study Population	Rates and Proportion of Drowning
Davis and Smith, 1982 [23]	South Africa (Cape Town)	Descriptive cross-sectional study	1979–1981 (3 years)	1,500,000 people (population in Cape Town)	285 (0.019%) drowning deaths §
Grainger 1985 [60]	Seychelles	Descriptive cross-sectional study	1959–1978 (20 years)	119 drowning deaths	5.95 ± 2.2 drownings per year (mean drowning rate)
Davis and Smith 1985 [24]	South Africa (Cape Town)	Descriptive cross-sectional study	1980–1983 (4 years)	1,600,000 people (population in Cape town)	Male: 38.7/100,000 Female: 8.3/100,000
Meel BL, 2008 [27]	South Africa (Mthatha)	Descriptive cross-sectional study	1993–2004 (12 years)	400,000 people (population in Mthatha)	Mean drowning rate: 7.1/100,000
Seleye-Fubara et al., 2012 [50]	Nigeria (Niger-delta region)	Descriptive cross-sectional study	1998–2009 (12 years)	85 drowning deaths	80% were unintentional drowning
Donson and Nickerk, 2013 [25]	South Africa	Descriptive cross-sectional study	2001–2005 (5 years)	Total population in five cities (Johannesburg, Durban, Cape Town, Port Elizabeth and Pretoria)	2.1/100,000
Joanknecht et al., 2015 [30]	South Africa: Cape Town	Descriptive cross-sectional study	2007–2013 (6 years)	75 children admitted for a submersion incident (near drowning and drowning)	10.7% of the study population drowned
Lin et al., 2015 [22]	Egypt South Africa	Ecological study	2009–2011 (3 years) 2007–2009 (3 years)	Entire population in the country Entire population in the country	1.5/100,000 2.5/100,000
Morris et al., 2016 [26]	South Africa (Pretoria)	Descriptive cross-sectional study	2002–2011	23,050 registered deaths 278 deaths due to external causes	1.2% (278) of the deaths were due to drowning
Kobusingye et al., 2017 [54] ‡	Uganda (Buikwe; Kampala; Mukono; Wakiso)	Mixed methods: Quantitative—Cross-sectional ǂ	Not stated	2804 people (population in the community)	502/100,000
Wu et al., 2017 [21]	Egypt South Africa	Ecological study	2000 and 2013	WHO world standard population WHO world standard population	Unintentional drowning rate 2000: 3.89/100,000 2013: 2.93/100,000 2000: 0.33/100,000 2013: 3.38/100,000
Saunders et al., 2018 [43]	South Africa (Western Cape)	Descriptive cross-sectional	2010–2016 (6 years)	Total population in Western Cape (not stated by the authors)	3.2/100,000

§ Drowning proportions was calculated using data provided in the article. ‡ For the purpose of the review, only the quantitative aspect of the study was included in the review.

Table 2. Studies describing drowning as part of other studies (including external causes and all causes) in Africa.

Authors, Reference, Year	Country	Study Design	Year	Study Population	Rates and Proportion of Drowning
Chitiyo 1974 [61]	Zimbabwe (Bulawayo area)	Descriptive cross-sectional study	1972	188 adult deaths (external causes)	11.17% (21) drowning deaths
Knobel et al. 1984 [28]	South Africa	Descriptive cross-sectional study	1966–1981 (15 years)	3248 children < 15 years (external causes)	356 drowning deaths (11%)
Kibel et al. 1990 [31]	South Africa	Descriptive cross-sectional study	1981–1985 (5 years)	14,118 children under 15 years of age (deaths due to external causes)	19% of all injury related deaths
Flisher et al. 1992 [42]	South Africa	Descriptive cross-sectional study	1984–1986 (3 years)	9288 adolescent deaths due to external causes	10.8% of all deaths due to external causes
Lerer et al., 1997 [32]	South Africa (Cape Town)	Descriptive cross-sectional	1994 (1 year)	3690 deaths due to external causes	2.6% (96) of all non-natural mortality was due to drowning
Kobusingye et al., 2001 [55]	Uganda (Mukono district)	Descriptive cross-sectional	1993–1998 (5 years)	34 fatal injuries (external causes)	27% (9) of fatal injuries were due to drowning
Moshiro et al. 2001 [59]	Tanzania	Descriptive cross-sectional study	1992–1998 (6 years)	64,756 persons in Dr es Salaam 146,359 (population in Hai) 103,053 (population in Morogoro) 1478 deaths due to injuries (external causes) all age groups	Overall drowning incidence not stated Female drowning rates/100,000 Dar es Salaam: 4.7 Hai District: 5.5 Morogoro: 5.1 Male drowning rates/ 100,000 Dar es Salaam: 9.2 Hai District: 10.2 Morogoro: 7.9
Lett et al., 2006 [53]	Uganda (Gulu district)	Descriptive cross-sectional study	1994–1999 (5years)	8595 people 397 deaths due to external causes	0.1/1000 people were due to drowning
Osime et al., 2007 [51]	Nigeria (Benin City)	Descriptive cross-sectional study	2001–2004 (4 years)	5446 trauma related deaths (external causes)	Drowning accounted for 0.8% of all trauma related deaths
Burrows et al., 2010 [35]	South Africa	Descriptive cross-sectional study	2001–2003 (2 years)	3,301,190 children aged 0–14 years 2923 injury related deaths (external causes) of children aged 0–14 years	Female: 2.1/100,000 Male: 5.3/100,000
Ohene et al., 2010 [46]	Ghana (Accra)	Descriptive cross-sectional	2001–203 (2 years)	151 injury related deaths (external causes) among adolescents aged 10–19 years	38% of deaths were due to drowning
Garrib et al. 2011 [40]	South Africa	Analytical cross-sectional	2000–2007 (7 years)	133,483 people 1022 injury related deaths (external causes)	3.3% due to drowning
Mendes et al., 2011 [29]	South Africa (Johannesburg)	Descriptive cross-sectional study	2006–2009 (4 years)	1760 unintentional injuries (external causes)	0.34% of the deaths were due to drowning [§]

Mamady et al., 2012 [58]	Guinea	Analytical cross-sectional study	2007	9,710,144 (total population) 7066 fatal injuries (external causes)	4.4/100,000
Odhiambo et al., 2013 [57]	Kenya	Analytical cross-sectional	2003–2008 (5 years)	220,000 people (total population) 11,147 adult deaths due to trauma (external causes)	0.2% (23) deaths were due to drowning
Weldearegawi et al., 2013 [45]	Ethiopia (Kilite Awlaelo surveillance site)	Descriptive cross-sectional study	2009–2011 (3 years)	409 deaths (all causes)	4.6% of all deaths were due to drowning
Streatfield et al., 2014 [20]	Burkina Faso Cote d'Ivoire Ethiopia The Gambia Ghana Kenya Malawi South Africa	Ecological study	2000-2012 (3 years)	111,910 deaths/ 12,204,043 person-years across Africa and Asia due to external causes	Rates/1000 person years Burkina Faso (Nouna): 0.00 Burkina Faso (Ouagadougou): 0.20 Cote d'Ivoire (Taabo): 0.14 Ethiopia (Kilite Awlaelo): 0.13 The Gambia (Farafenni): 0.11 Ghana (Dodowa): 0.28 Ghana (Navrongo): 0.48 Kenya (Kilifi): 0.18 Kenya (Kisumu): 0.22 Kenya (Nairobi): 0.18 Malawi (Karonga): 0.19 South Africa (Africa Centre): 0.19 South Africa (Agincourt): 0.07
Chasimpha et al., 2015 [48]	Malawi (Karonga district)	Nested case-control	2002 2012	59,947 people (children and adults) in Karonga district Deaths due to external causes	Unintentional drowning rate: 8.6/100,000
Kone et al., 2015 [56]	Cote d'Ivoire	Descriptive cross-sectional study	2009–2011 (3 years)	39,422 people (total population) 712 deaths (all causes)	Unintentional drowning rates **Male *** 5–14: 0.1% 15–49: 0.3% **Female *** 5–14 years: 0.02%
Matzopoulos et al., 2015 [36]	South Africa	Descriptive cross-sectional study	2009	52,493 injury related deaths (external causes)	Unintentional drowning 3.3/100,000
Olatunya et al., 2015 [52]	Nigeria (Ekiti State)	Descriptive cross-sectional study	2012–2014 (2 years)	5264 children admitted for injury related incidents (external causes)	Drowning accounted for 4.54% of all injuries
Pretorius and Niekerk, 2015 [33]	South Africa: Guateng	Descriptive cross-sectional study	2008–2011 (2 years)	Total population in Gauteng 5404 fatal injuries (external causes) in children aged 0–19 years	8.9% of all fatal injuries were due to drowning
Groenewald et al., 2016 [38]	South Africa: Western Cape	Descriptive cross-sectional study	2011	2412 deaths (all causes) of children under 5 years of age	Drowning accounted for 2.8% of all deaths
Mathews et al., 2016 [37]	South Africa: Western Cape and KwaZulu-Natal	Descriptive cross-sectional study	2014	711 child deaths (all causes)	Drowning deaths accounted for 2.5% of all deaths

Reid et al., 2016 [39]	South Africa: Western Cape	Descriptive cross-sectional study	2011	180,814 children under 5 years of age (total population) 1051 under-5 deaths (all causes)	11% of all deaths were due to drowning
Meel BL, 2017 [34]	South Africa	Descriptive epidemiology	1996–2015 (20 years)	24, 693 deaths due to unnatural (external) causes	5.1% of unnatural deaths were due to drowning
Purcell et al., 2017 [49]	Malawi: Lilongwe	Descriptive cross-sectional study	2008–2013 (6 years)	30,462 children with traumatic injuries 343 deaths due to external causes	11.4% of the deaths were due to drowning
Erasmus et al., 2018 [41]	South Africa	Descriptive cross-sectional study	2010–2014 (5 years)	184 injuries related (external causes) deaths over the time period	75% (138) of the deaths were due to drowning
Gelaye et al., 2018 [44]	Ethiopia	Descriptive cross-sectional study	2009–2013 (5 years)	623 injury related deaths (external causes)	21.8% (136) deaths were due to drowning
Ossei et al., 2019 [47]	Ghana	Descriptive cross-sectional study	2008–2016 (8 years)	1470 unnatural deaths (external causes)	7.14% of the deaths were due to drowning

§ Drowning proportions were calculated using data provided in the articles. * Other age groups reported no drowning deaths.

3.3. Potential Risk Factors

In Table 3, only two studies reported risk factors [48,58]. One study identified risk factors associated with drowning [58] and the other study reported risk factors of a wider study [58]. The identified risk factors were being a fisherman [58], having fishing as source of income [58], being male [58] and older age with the odds of drowning increasing with increasing age from 2.0 to 8.9 [58]. Potential risk factors were identified in 26 studies based on the rates of drowning reported and these potential factors include age, gender, ethnicity, alcohol, access to bodies of water, age of boat and carrying capacity of the boat, weather and summer season. In 19 studies, age was identified as a potential risk factor [24–28,30–33,37,40,42,46,47,55,57–60], with 13 studies reporting higher rates of drowning among children and adolescents [25,27,28,30–33,37,42,43,46,47,59]. In addition, males were reported to have higher rates of drowning compared to females in 15 studies [24–28,35,36,40,43,45–47,57,58,60]. Furthermore, six studies reported the rates of drowning for different races [24,26,28,31,35,42]. However, race as a potential risk factor varied between the included studies with three studies classifying the race by age groups [24,31,42]. The other three studies reported the rates of drowning for all age groups without grouping them [26,28,35]. Among studies reporting drowning rates for race by age groups, children aged <1 year–5 years of white African ethnicity were most vulnerable to drowning compared to other races. By contrast, drowning was more prevalent in adolescents and adults of black African ethnicity and Asian ethnicity [24,31,42}. Where no age classification was used, blacks of African ethnicity were reportedly had higher drowning rates in two studies [26,35], while one study reported a higher rate of drowning among whites of African ethnicity [28]. Other potential risk factors identified were alcohol [23,25,26], summer season [24,26,28,42,43], boat age and overloading of the boat [64], stormy weather [64] and access to bodies of water [24–26,31,43,48,54,55].

Table 3. Studies discussing potential risk factors for drowning among all age groups in Africa.

Authors, Reference, Year	Country	Study Population	Proportions or Rates of Potential Risk Factors		Potential Risk Factors/Risk Factors Identified
Davis and Smith, 1982 [33]	South Africa (Cape Town)	1,500,000 people			Alcohol
Knobel et al. 1984 [28]	South Africa	3248 children < 15 years	Race		Race: whites
			Coloured	10.7%	
			White	**16.1%**	
			Black	7.9%	
			Gender		Male
			Male	**11.7%**	
			Female	9.7%	
			Age		
			<1 year	6.9%	Age: 6–14
			1–5 years	12.8%	
			6–14 years	**20.3%**	Summer season
					Weekends
Davis and Smith 1985 [24]	South Africa (Cape Town)	1,600,000 people	Race		Race: Black race for adults >30 years
			Black race	**32.3/100,000**	White race for children 0–5 years
			Colored	24.2/100,000	Male
			White	13.4/100,000	
			Gender		
			Male	**38.7/100,000**	
			Female	8.3/100,000	
			Age		Age: 21–30
			0–5 years	13.3%	
			6–10 years	5.8%	
			11–15 years	4.9%	
			16–20 years	10.98%	
			21–30 years	**25.14%**	Summer season
			31–40 years	15.61%	Swimming pools
			>40 years	24.28%	Alcohol
Grainger 1985 [60]	Seychelles	119 drowning deaths	Age		Age: 40–49 years
			0–9 years	6.72%	Epilepsy
			10–19 years	13.44%	Head injury
			20–29 years	16.8%	Time of day: 12–2 pm
			30–39 years	18.5%	
			40–49 years	**21.8%**	

			50–59 years	12.6%	
			60–69 years	5.88%	
			70+ years	4.2%	
				Gender	
			Male	**109 deaths**	Male
			Female	10 deaths	
Kibel et al. 1990 [31]	South Africa	14,118 children under 15 years of age (injuries related death)		Age	Age: 1–4 years
			<1year	7.4%	
			1–4 years	**23.0%**	
			5–14 years	20.1%	
			Race	<1 year	White race for children <1 year to 4 years
			Blacks	6.7%	Black race for children aged 5–14 years
			Whites	**9.5%**	Site:
			Coloured	8.3%	Swimming pools for white children
			Asians	6.4%	Dams and rivers for older black children
				1–4 years	
			Blacks	18.8%	
			Whites	**42.7%**	
			Coloured	22.1%	
			Asians	9.4%	
				5–14 years	
			Blacks	**21.9%**	
			Whites	12.7%	
			Coloured	21.2%	
			Asians	9.4%	
Flisher et al. 1992 [42]	South Africa	9288 adolescent deaths due to external causes	Race	10–14 years	Age: 10–14 years
			Whites	6.3%	Black race for adolescents 10–14 years old
			Coloured	25.2%	Asian race for adolescents 15–19 years old
			Asians	12.7%	Summer season
			Black	**24.2%**	
			Race	15–19 years	
			Whites	4.2%	
			Coloured	9.7%	
			Asians	**12.5%**	
			Black	6.3%	

Lerer et al., 1997 [32]	South Africa (Cape Town)	3690 non-natural mortality	Age	Number of drowning deaths	Age: 0–14 years
			0–14 years:	**35**	
			15–24 years:	10	
			25–34 years	16	
			35–44 years	16	
			45–54 years	12	
			55–64 years	3	
			65–74 years	1	
			75+ years	3	
Kobusingye et al., 2001 [55]	Uganda (Mukono district)	34 fatal injuries	Age	% of drowning	Age: 10–39 years
			<10 years	0%	Extensive water surface
			10–19 years	18%	
			20–29 years	18%	
			30–39 years	18%	
			40–49 years	0%	
			>50 years	0%	
Moshiro et al. 2001 [59]	Tanzania	1478 deaths due to injuries all age groups	Female gender/100,000 population		Females;
				Dar es Salaam / Hai District / Morogoro	0–4 years (across the three districts)
			0–4 years	**7.0** / **17.1** / **6.9**	
			5–14 years	2.2 / 5.0 / 6.0	Males:
			15–59 years	5.2 / 3.0 / 4.2	Dar es Salaam: 15–59 years
			60+ years	2.8 / 4.6	Hai District: 0–4 years
					Morogoro: 60 years and above
			Male gender/100,000 population		
				Dar es Salaam / Hai District / Morogoro	
			0–4 years	3.4 / **12.3** / 12.1	
			5–14 years	4.9 / 9.0 / 3.6	
			15 -59 years	**12.4** / 10.6 / 7.9	
			60+ years	8.5 / **16.1**	

Meel BL, 2008 [27]	South Africa (Mthatha)	405 drowning deaths		Male	Female	Male
			1–10 years	**23.4%**	**6.9%**	Age: 1–20 years
			11–20 years	**15.2%**	**9.2%**	
			21–30 years	9.8%	4.7%	
			31–40 years	11.3%	2.8%	
			41–50 years	5.0%	1.3%	
			51–60 years	3.8%	0.6%	
			61+ years	3.1%	2.5%	
Burrows et al., 2010 [35]	South Africa	2923 injury deaths of children aged 0–14 years		Drowning rate per 100,000		
			Gender			
			Female		2.1	Buffalo City
			Male		**5.3**	
						Male
			Population group			
			Asian		0.9	
			White		4.3	
			Coloured		2.0	
			African		**4.3**	African
			City			
			Tshwane		2.9	
			Cape Town		2.2	
			Johannesburg		4.2	
			eThekwini		3.8	
			Nelson Mandela		3.7	
			Buffalo City		**9.2**	
Ohene et al., 2010 [46]	Ghana (Accra)	151 injury related deaths among adolescents aged 10–19 years		Gender		Male
			Female		25%	
			Male		**44%**	
				Age		
			10–14 years		**46%**	Age: 10–14 years
			15–19 years		33%	

Garrib et al. 2011 [40]	South Africa	1022 injury related deaths	Age		Children aged 0–15 years	
			0–15 years	**65%**		
			>15 years	35%		
			Gender (rate/100,000 person years)			
			Male	**6.2**	Male	
			Female	3.4		
Mamady et al., 2012 [58]	Guinea	7066 fatal injuries			Female	Ref
					Male	**OR 2.8; 95% CI (2.3–3.5)**
					0–4 years	Ref
					5–14 years	**OR 2.0; 95% CI (1.1–3.5)**
					15–24 years	**OR 8.9; 95% CI (5.3–15.0)**
					25–64 years	**OR 7.0; 95% CI (4.2–11.7)**
					65+ years	**OR 7.9; 95% CI (4.4–14.3)**
Seleye-Fubara et al., 2012 [50]	Nigeria (Niger-delta region)	85 drowning deaths				Alcohol
						Hard drugs
						Epilepsy
Donson and Nickerk, 2013 [25]	South Africa	1648 drowning deaths	Age (rate/100,000)			
			0–4 years	**6.3**	0–4-year age group	
			5–14 years	2.2		
			15–29 years	1.7	Swimming pools	
			30–44 years	1.8		
			45–59 years	1.4	Alcohol use	
			60+ years	1.2		
			Gender (rate/100,000)		December	
			Male	**3.4**		
			Female	0.9	Male	
Odhiambo et al., 2013 [57]	Kenya	11,147 adult deaths due to trauma	Gender			
			Female	13%	Male	
			Male	**87%**		
			Age			
			<40 years	**83%**	Young adults (<40 years of age)	
			>40 years	17%		
Weldearegawi et al., 2013 [45]	Ethiopia (Kilite Awlaelo surveillance site)	409 deceased	Gender		Male	
			Female	1.7%		
			Male	**2.9%**		

Chasimpha et al., 2015 [48]	Malawi (Karonga district)	59,947 people (children and adults) in Karonga district			Children from fishing households	OR 3.07; 95% CI (1.03–9.10) ‡
					Adult male with fishing as a source of income	OR 2.45; 95% CI (1.17–5.14) ‡
					Adult males who are fishermen	OR 2.92; 95% CI (1.42–5.98) ‡
					Adult females who have other occupations	OR 4.04; 95% CI (1.22–13.4) ‡
Joanknecht et al., 2015 [30]	South Africa (Cape Town)	75 children admitted for a submersion incident			Public pools and the ocean for children older than 5 years of age Private pools, baths and buckets for children less than 5 years	
Matzopoulos et al., 2015 [36]	South Africa	52,493 injury related deaths	Gender (rate/100,000 population)		Male	
			Female	1.2		
			Male	**5.7**		
Pretorius and Niekerk, 2015 [33]	South Africa (Guateng)	5404 fatal injuries in children aged 0–19 years	Age			
			0–1 year	9.4%	Age: 2–3 years	
13.4%			**2–3 years**	**16.8%**		
			4–6 years	13..4%		
			7–12 years	13.1%		
			13–19 years	3.0%		
Mathews et al., 2016 [37]	South Africa (Western Cape and KwaZulu-Natal)	711 child deaths	Age			
			<1 year	1.1%	Age: 1–4 years	
			1–4 years	**5.8%**		
			5–14 years	5.0%		
			15–17 years	1.9%		
Morris et al., 2016 [26]	South Africa (Pretoria)	346 deaths due to external causes	Gender			
			Female	21%	Male	
			Male	**79%**		
			Race			
			Black	**71%**	Black race	
			White	24%		
			Coloured	4%		
			Asian	1%		
			Age		Age >18 years	
			<1 year	15%		

			1–2 years	19%	Summer months (December to February)
			2–13 years	18%	Alcohol
			13–18 years	3%	Swimming pool
			>18 years	**45%**	
Kobusingye et al., 2017 [54]	Uganda (Buikwe; Kampala; Mukono; Wakiso)	2804 people (population in the community)			Access to water bodies (for transportation or fishing)
					Overloading
					Stormy weather
					Old age of boats
Meel BL, 2017 [34]	South Africa	24,693 deaths due to unnatural causes	Gender		Female
			Female	**6.07%**	
			Male	4.8%	
Gelaye et al., 2018 [44]	Ethiopia	623 injury related deaths	Gender		Female
			Female	**22%**	No formal education (illiterates)
			Male	21.1%	
Saunders et al., 2018[43]	South Africa (Western Cape)	1391 drowning deaths	Age (rate/100,000 population)		Age: 0–19 years
			Children (0–19 years)	3.8	
			Adults (20+ years)	3.0	
			Gender (rate /100,000 population)		
			Female	1.2	Male
			Male	**5.3**	Access to large open bodies of water
					Summer season (December, January, February)
Ossei et al., 2019 [47]	Ghana	1470 unnatural deaths	Age		Age: 0–9 years
			≤9 years	**40%**	
			10–19 years	17.14%	
			20–29 years	17.14%	
			30–39 years	10.48%	
			40–49 years	6.67%	
			50–59 years	3.81%	
			60–69 years	2.86%	
			≥70 years	1.90%	
			Gender		Male
			Female	22.9%	
			Male	**77.1%**	

‡ Risk factors for external death, which also applies to drowning.

3.4. Prevention Strategies

Sixteen (16) studies proposed prevention strategies to reduce drowning rates in Africa [23–27,30,31,42,44–46,48,53,54,59,60]. These prevention strategies include increased supervision of children around bodies of water, aquatic education and training about basic life support measures, training about life skills in communities, community awareness and implementation of legislation to prevent drowning (Table 4). Using the hierarchy of controls [64], fourteen of the sixteen studies proposed administrative control/preventive measures, which included education/training on basic life support, legislative laws and increasing public awareness [23,25,27,30,31,42,44–46,48,53,54,59,60]. Two studies proposed engineering control measure that include building life safety facilities and the use of barriers and safety nets around swimming pools [24,26].

Table 4. Studies discussing proposed prevention strategies for drowning among all age groups in Africa.

Authors, Reference, Year	Country	Study Population	Prevention Strategy	Hierarchy of Controls
Davis and Smith, 1982 [23]	South Africa (Cape Town)	1,500,000 people	Increase public awareness	Administrative control
			Media campaign to reduce drinking in combination with aquatic activities	
Davis and Smith 1985 [24]	South Africa (Cape Town)	1,600,000 people	Live saving facilities	Engineering control
			Improved adult supervision of children	Administrative control
Grainger 1985 [60]	Seychelles	165 deaths due to accidents 119 drowning deaths	Primary health education proposed	
Kibel et al. 1990 [31]	South Africa	14,118 children under 15 years of age	Increase public awareness	Administrative control
			Safety legislation to reduce environment hazards	Administrative control
Flisher et al. 1992 [42]	South Africa	9288 adolescent deaths	Media efforts/ intervention to prevent drowning	Administrative control
Moshiro et al. 2001 [59]	Tanzania	1478 deaths due to injuries	Education	Administrative control
Lett et al., 2006 [53]	Uganda (Gulu district)	397 deaths due to injuries associated with war	Formal monitoring by international bodies with no political or economic interest in the conflict.	Administrative control
Meel BL, 2008 [27]	South Africa (Mthatha)	405 drowning deaths	Education and training at schools about life skills	Administrative control
Ohene et al., 2010 [46]	Ghana (Accra)	151 deaths among adolescents aged 10–19 years	Aquatic safety education	Administrative control
			Supervision near recreational water bodies	Administrative control
Donson and Nickerk, 2013 [25]	South Africa	1648 drowning deaths	Public aquatic safety education	Administrative control
			Implementation of evidence-led safety measures	Administrative control
			Water safety legislation	Administrative control
Weldearegawi et al., 2013 [45]	Ethiopia (Kilite Awlaelo surveillance site)	409 deceased	Integrating occupational and safety education with existing health programme to reduce mortalities associated with accidents	Administrative control
Chasimpha et al., 2015 [48]	Malawi (Karonga district)	59,947 people (children and adults)	Improved supervision of children around bodies of water	Administrative control
Joanknecht et al., 2015 [30]	South Africa (Cape Town)	75 children admitted for a submersion incident	Community based education and prevention programs focusing on restricting access to private pools for young children	Administrative control
Morris et al., 2016 [26]	South Africa (Pretoria)	346 deaths due to external causes	Public education regarding basic life support measures and dangers of alcohol consumption and swimming	Administrative control
			Use of safety nets/barriers	Engineering control
Kobusingye et al., 2017 [54]	Uganda (Buikwe; Kampala; Mukono; Wakiso)	2804 people	Enforce boat construction and maintenance regulations	Administrative control
			Loading limits	Administrative control
			Boat crew training	Administrative control

			Use of weather forecast	Administrative control
Gelaye et al., 2018 [44]	Ethiopia	623 injury related deaths	Community awareness	Administrative control

3.5. Methodological Quality Assessment

The QATSDD scores ranged from 53% to 100% (Supplementary Table S1). Thirty-three studies which scored above 80% [20–22,25,26,29–41,43–49,52–59], were categorised as having excellent methodological quality, and included details about sampling, data analysis, strengths and limitations of the study. The other studies were considered to be of good methodological quality [23,24,27,28,42,50,51,60,61] and no study scored below 50%. The included studies utilised retrospective data or collected information retrospectively from participants. Inaccuracy and incompleteness of the data may be associated with the use of retrospective data. In addition, misclassification bias may have been introduced into the studies that used retrospective data. Furthermore, depending on the participants, recall bias may have been introduced into some of the studies. These biases could have underestimated or overestimated the burden of drowning in Africa.

4. Discussion

Drowning is a significant public health burden in Africa and the findings of this systematic review suggest that there is a huge variation in drowning mortality across Africa. The highest proportion of drowning (approximately 80%) was reported in Nigeria [50], while the highest rate reported (502/100,000 population) was observed in Uganda [54]. Although only two studies identified risk factors which includes being a fisherman, and older age [48,58]; we identified potential risk factors based on previous evidence [3]. The limited evidence suggests that male gender and young people are at higher risk for drowning especially children and adolescents. In addition, other potential risk factors identified were being of black African ethnicity, alcohol use, access to bodies of water, age of boat and carrying capacity of the boat, weather and summer season. This systematic review has highlighted the need for more data on drowning prevalence, together with good epidemiological studies across all African countries to describe the patterns of drowning and understand risk factors to guide prevention initiatives.

Due to the limited data available, quantifying the prevalence of drowning in Africa was challenging. This finding was echoed in a study of drowning in low- and middle-income countries by Tyler et al. who reported that inconsistences in data collection for drowning poses as a challenge for data synthesis [8]. Although the estimated rates and proportions may be considered high, in majority of the studies, drowning was reported as part of a wider injury study. Of the 54 countries in Africa, only 15 countries had some published data on drowning with the majority (57%) of the literature originating from South Africa. In many African countries, cases go unreported and the lack of an injury surveillance system as seen in many LMIC also contributes to the limited data [65]. This is consistent with the findings of two recent systematic reviews describing the burden of drowning in South Africa and Tanzania [16,17]. Saunders et al. and Sarrassat et al., reported that strengthening the existing surveillance systems or establishing new ones are needed for consistent and detailed drowning surveillance [16,17]. In addition, as many of the drowning cases result in death at the time of the event, only a small proportion present at the hospital or medical facilities [66]. Both the lack of the injury surveillance system and underreporting of drowning cases prevent accurate documentation of drowning mortality in health records. According to WHO, approximately 90% of global drowning deaths occur in LMICs. Africa as a region had an estimated 73,635 drowning deaths in 2016 which accounted for approximately 23% of the total drowning deaths globally [67]. However, data collection in the region is limited, and hence the statistics from Africa underrepresents the true burden of drowning in the region [4].

Many of the potential risk factors associated with drowning identified in this review are similar to those reported in previous systematic reviews. Drowning occurred more frequently in males between the ages of 0 to 15 years. Specifically, highest drowning occurrences were found in the 0–5-year age group. In LMICs, drowning rates among children were higher among children aged 1–4 years, followed by children aged 5–9 years with males being twice as likely as females to drown [8]. In addition, younger children were found to drown in private pools or baths, whereas older children were found to drown in public swimming pools, rivers, dams or in the ocean. Given that a majority

of the studies originated from South Africa, drowning in swimming pools occurred more in white African children, whereas drowning in dams and rivers were found to occur in older black African children [24,31]. Although it is not evident that socioeconomic status is a potential risk factor in this review, children from low-income households may not have access to private swimming pools and are more likely to access natural bodies of water around the house as reported in other LMICs [8]. Evidence suggests that a lack of child supervision and the lack of safety barriers has been associated with high drowning rates among children [66]. Furthermore, access to other water bodies using boats or through fishing, depending on occupational or recreational purposes was also considered as a potential risk factor [48,54]. Specifically, children and adults from fishing households, are more likely to access these types of water bodies daily, requiring significant surveillance and awareness strategies for children in such settings. Other potential risk factors such as alcohol consumption has been shown to be associated with drowning especially among adolescents and adult [68]. As blood alcohol concentration level rises, judgement, balance and vision may be impaired, increasing the risk of drowning. Binge drinking is common in some African countries and has been reported to be associated with drowning among adult men [23–26,50]. This calls for increased awareness of the risk of alcohol consumption in conjunction with swimming.

The prevention strategies proposed by sixteen studies includes focusing on pool safety such as restricting access to private pools for young children, education and training at schools on life skills, increasing public awareness through media campaigns, and the implementation of water safety legislation, community awareness, improved supervision of children around water bodies, building lifesaving facilities and enforcement of boat construction and maintenance regulations. Using the hierarchy of controls which is a system used to minimize or eliminate hazards [64], only two studies proposed engineering controls as a way of preventing drowning [24,26]. All other studies proposed prevention strategies that require administrative controls which is the least effective way to prevent drowning [23,25,27,30,31,42,44–46,48,53,54,59,60]. However, prevention interventions and methods may not be consistent between countries due to the diversity and variation in their epidemiology, demographic and cultural characteristics [8]. There is no simple solution to addressing the burden of drowning in all countries, therefore strategies would have to be designed specifically for each country, keeping in mind the cultural, economic and social structures.

4.1. Implications for Policy and Future Research

The findings of this review suggest that there is limited evidence and data on the burden of drowning in Africa. The 2017 Global Burden of Disease (GBD) using statistical models estimated that drowning contributed approximately 0.53% of the total deaths in Africa as a region. Using the GBD to obtain country specific estimates for the countries included in the review showed an average drowning mortality ranging from 1.63 per 100,000 population to 5.73 per 100,000 population [69]. However, existing data on drowning in many countries in Africa are scarce. Therefore, establishing specific databases about injuries like drowning for surveillance and data collection would aid in development of policies and prevention strategies across the different countries. Evidence from research conducted in high income countries like Australia, Canada and New Zealand suggest that robust high-quality data and better data collection system would enable the creation of targeted and effective drowning prevention interventions [70]. Developing the databases will enable cross-country comparison which allows for identification of similarities and improvements in data collection. However, establishing the databases may be challenging for some African countries, especially if drowning is not among the national health priorities. In addition, there was little exploration of the risk factors associated with drowning, highlighting a gap in the literature. Good epidemiological studies are needed to identify the risk factors and evaluate the proposed prevention strategies for drowning in Africa. Furthermore, future research should focus on the intent for drowning in Africa, which would help to inform policies and prevention interventions. A recent article on intentional drowning reported an increasing rate of intentional drowning and proposed a multidisciplinary collaboration public health and other services including mental health, education and drowning prevention organisations to prevent intentional drowning [71].

4.2. Strengths and Limitations

To our knowledge, this is the first systematic review that describes the epidemiology, risk factors and prevention strategies of drowning in Africa. However, comparing mortality data across the countries within Africa needs to be undertaken with caution given the different measures used to analyse the burden of drowning. Some studies were population-based studies, while other studies reported drowning as a part of a wider study (such as external causes of deaths or all causes of death). An example of the latter is the study by Seleye-Fubara et al. which reported that unintentional drowning accounted for approximately 80% of all drowning deaths [50]. In addition, the completeness and reliability of the data in each country varied with some studies using the national mortality surveillance statistics, while other studies relied on hospital-based data, mortuary-based data and demographic surveillance data. The variability in the sources of data may account for the variable rates of drowning reported in the review.

Other limitations include reviewing only articles published in peer-reviewed journals. We may have missed other high-quality studies that are published in non-peer reviewed journals. In addition, we excluded non-English articles, there is a possibility that we may have missed articles from Africa published in other languages. Furthermore, the majority of studies were from South Africa, it is conspicuous that there is a paucity of data from many countries in Africa. It is uncertain whether such strategies, if implemented, can be generalizable to other African countries besides South Africa.

5. Conclusions

There is a need to address the high rate of drowning in Africa. It is imperative that governments across the nations of Africa establish good injury surveillance systems to accurately understand the burden of drowning to inform approaches for drowning prevention. Good epidemiological studies across all African countries are needed to describe the patterns of drowning and understand risk factors. Further research is needed to investigate the risk factors and to evaluate prevention strategies.

Supplementary Materials: The following are available online at www.mdpi.com/xxx/s1. Table S1: Medline search strategy; Table S2: Quality assessment of included studies using the quality assessment tool for studies with diverse designs (QATSDD)**;** Figure S1: Schematic of study inclusion.

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