ASSESSMENT OF DROWNING DATA COLLECTION PROCESSES IN LOW-AND MIDDLE-INCOME COUNTRIES:

A SCOPING REVIEW REPORT

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ABBREVIATIONS

ICD	- International Classification of Diseases
LIC	- Low Income Country
LMIC	- Low and Middle-Income Country
VA	- Verbal Autopsy
WHO	- World Health Organization

INTRODUCTION

Drowning is a serious and neglected public health threat, causing morbidity and mortality worldwide. According to the World Health Organization (WHO), drowning is the third leading cause of unintentional injury death, accounting for 7% of all injury-related deaths (WHO, 2021). In the year 2019, an estimated 236,000 people died from drowning, and 90% of these deaths occurred in low- and middle-income countries (LMICs) (WHO, 2021), where the number of drowning deaths is considered underreported due to limited resources to collect data (Linnan *et al.*, 2007; Tyler *et al.*, 2017). WHO's global drowning mortality estimates are based only on deaths where drowning is classified as the external cause of death (i.e. where drowning was the event that caused the death, e.g. a child drowning in a well), and not those where drowning was *only the consequence* of another classified external cause of death (e.g. drowning by suicide and homicide, drowning cases related to natural hazard disasters and water transport incidents) (WHO, 2014; Mugeree *et al.*, 2022). If the external cause of death is included, the number of drowning deaths could be much higher.

In specific LMIC settings, the drowning death records may not be accurate due to several reasons, such as: the bodies of affected people may not be quickly located by the local authorities, e.g. the police may regard drowning deaths as suspicious; there is little incentive to seek medical care for a person who is dead; and there is often a cost associated with reporting a death (Lin, Wang and Lu, 2019). While the circumstances that lead to drowning make the cause of death relatively easy to determine, the drowning burden is frequently challenging to measure. Also, data on nonfatal drownings, which could reveal something about the burden of serious injury and lifelong disability, are not routinely collected (WHO, 2014).

There is a clear desire and need to improve local-level data collection that can provide more accurate data on the burden of drowning and the *context* or *circumstances* surrounding drowning to inform the design of suitable interventions. However, data is often missing or not collected because drowning deaths frequently occur outside the formal healthcare system and are not recorded in the country's vital registration system (VRS) (Hsiao *et al.*, 2012; Dandona *et al.*, 2019). Verbal Autopsy (VA) has become a commonly used tool or instrument for determining the cause of death in LMIC settings (WHO, 2023), either as part of large-scale household surveys or within geographically specific health and demographic surveillance systems (WHO, 2024a).

Whilst the primary goal of a VA is establishing a *cause of death*, there is increasing interest in using the tool to identify risk factors for injury deaths, including drowning. Although this offers ease of identifying injury deaths, there are no specific questions in the VA questionnaire that interrogate the context or the circumstances surrounding death, except for establishing the role of the deceased in

road traffic accidents. As such, context can only be ascertained in the *open narrative* part of the questionnaire. The lack of guidance for data collectors means that this opportunity to determine useful contextual factors that could inform intervention design is lost. Therefore, this study explored the minimum parameters needed to complement a *VA instrument for circumstances of drowning death*. To do so, a scoping review was conducted to identify how drowning data is collected in LMIC settings and what challenges and opportunities exist in using the VA instrument to collect information on context-specific and modifiable risk factors for injury deaths. Considering this, the **specific objectives** of this study are:

1. To identify the types of drowning data reported from LMIC settings.
2. To assess the methods employed in LMIC settings to collect drowning data and identify both the opportunities and challenges of the processes.
3. To identify the data collection instruments used and the minimum parameters collected especially for the VA instrument.
4. To gather information on organisations or individuals whose work has identified challenges and opportunities in using VA to collect context-specific and modifiable risk factors for injury deaths in LMIC settings.

Approach

The scoping review was underpinned by the WHO's (2014) drowning risk framework, which focuses on three components: What are the risks? Who is at risk? Where are the risks?

What are the risks?

According to WHO (2014) drowning happens in many ways, and various prevention strategies are needed to target the most significant risks. The main risk factors are lack of physical barriers between people and water, particularly close to homes; lack of (or inadequate) supervision of young children; uncovered or unprotected water supplies and lack of safe water crossings; lack of water safety awareness and risky behaviour around water; travelling on water, especially on overcrowded or poorly maintained vessels; flood disasters, whether from extreme rainfall, storm surges, tsunamis, or cyclones.

Who is at risk?

According to WHO's drowning risk framework, children under five and males under 25 years of age are high-risk groups. "Children aged under 12 months are relatively immobile and entirely dependent on caregivers. They can drown very quickly and in very little water, and in water containers that may not be perceived as risks (for example, in a bucket or a toilet)" (WHO, 2014, p.9). Children who are mobile but too young to recognise danger or to get out of the water are at risk, especially in the absence of barriers and capable supervision. Adolescents and adults who engage in risky behaviour around water, including consuming alcohol, are also at high risk of drowning (WHO, 2024b).

Where are the risks?

According to WHO (2014, p.12), "Wherever there is water there is a threat of drowning […] People in low-and middle-income countries interact with water differently from those in high-income countries, and the general level of economic and social development in low- and middle-income countries means exposure to water is riskier". Circumstances that lead to exposure to water include collecting water, living near water, travelling on water, working on or around water, flood disasters, and where assistance is limited (WHO, 2014).

Definitions of Terms:

For the purpose of the study, the following definitions were used.

Table 1: Definitions of Terms

Term	Definition
Drowning	Drowning is the process of experiencing respiratory impairment from submersion/immersion in liquid. Drowning outcomes are classified as death, morbidity, and no morbidity (WHO, 2024b).
Fatal and nonfatal drowning	Fatal drowning happens when the drowning results in death. Nonfatal drowning occurs when a person survives a drowning incident. Nonfatal drowning has a range of outcomes, from no injuries to very serious injuries such as brain damage or permanent disability (CDC, 2024).
VA Instrument	VA is a structured interview with the caregivers or next of kin of the deceased that can be used to determine the most

	likely cause of death where no physician can ascertain the dead (WHO, 2022a). The 2022 WHO VA Instrument comprises a short list of causes of death of public health importance that can be ascertained from a limited number of questions suitable for use in VA interviews and amenable to automated assignment of cause of death using analytical software (WHO, 2022b).
Low and Middle-Income Countries (LMIC)	As per the World Bank's 'country classifications by income level', LMICs include low, lower-middle, and upper-middle economies (WB, 2023[1]). A low-income economy is defined as having a GNI (Gross National Income) per capita of $1,135 or less in the year 2022; lower-middle-income economies are those with a GNI per capita between $1,136 and $4,465; and upper-middle-income economies are those with a GNI per capita between $4,466 and $13,845 (WB, 2024).

[1] https://blogs.worldbank.org/en/opendata/new-world-bank-group-country-classifications-income-level-fy24

DATA COLLECTION PROCEDURE

Eligibility Criteria for including studies in the review

We used the PCC (Population (or Participants)/Concept/Context) framework (Pollock *et al.*, 2023; University of South Australia, 2024) to conduct the scoping review. The PCC framework helps to identify the key concepts in systematic scoping reviews and to determine the inclusion criteria and detailed search structure outline.

Table 2: Inclusion Criteria

1. Population	People at risk of fatal and nonfatal drowning
2. Concept	Fatal and nonfatal drowning
3. Context	Primary studies in the English language, regardless of study design, and published after the 31st of December 2011. Also, as per the funder's instruction, grey literature from Bangladesh, South Africa, and Uganda were included in the review. Project collaborators from these countries obtained the literature for review.*

*We chose to review the records published after the 31st of December 2011 for a couple of reasons. First, the third International Life Saving Federation World Conference on Drowning Prevention organised by the Royal Life Saving Society – Australia, took place in the year 2011 in Da Nang – Vietnam (RLSA, 2011). This conference has been considered a landmark event in building a global platform to reduce drowning (ILS, 2014). Second, the reliability of evidence changes with time, so the last 12 years were considered an appropriate time frame.

Criteria for excluding studies not covered in inclusion criteria

The following exclusion criteria were used for the screening phase:

1. Studies conducted in settings other than LMICs
2. Publications not reporting drowning-related data
3. Secondary studies (Reviews)
4. Publications not in the English language and published before 2012

Database Search

Search Terms

The search terms identified by the initial literature search were categorised into three main groups: risk group, condition, and outcome. To expand the results, specific risk groups were removed from the final search strategy (see **Table 3**).

Table 3: Search Strategy

	Inclusion/Exclusion Criteria	**Terms**	**Keywords**	**Strategy - Abstract**
1	Concept (phenomena of interest)	Condition	Drown	drown* OR immers* OR submer*
			Immersion	
			Submerge	
2	Context	Result	Risk	risk* OR hazard* OR accident* OR fatal* OR injur* OR morbidit* OR death* OR mortalit* OR decease* OR "loss of life" OR autops*
			Injury	
			Morbidity	
			Death	
			Mortality	
			Verbal Autopsy	
1 – 2 AND	Combination of criteria	Expanders	Apply related words	-
			Apply equivalent subjects	
		Limiters	Date of Publication: 2012/01/01-2023/09/30	-
			Human	

Search Methods

To find relevant publications, electronic databases, grey literature sources, and supplementary search methods, such as academic search engines and reference lists of the selected publications for full-text reading, were used.

Electronic Databases

The following bibliographic databases, which allow simple and advanced database search options, were used to find journal articles and other published documents related to the review question.

- Medline
- EMBASE
- Web of Science
- Social Sciences Citation Index

Websites and Databases of International Organisations

The following international organisations' websites were used to find reports and other published documents related to the review question.

- WHO Data - https://www.who.int/data/collections
- WHO Global Health Observatory - https://www.who.int/data/gho
- The Humanitarian Data Exchange - https://data.humdata.org/
- World Bank Health Data - https://data.worldbank.org/topic/8
- UN Data - https://data.un.org/
- UNICEF Data - https://data.unicef.org/
- Institute for Health Metrics and Evaluation - https://www.healthdata.org/
- Health Data Collaborative - https://www.healthdatacollaborative.org/
- CDC Data & Statistics - https://www.cdc.gov/datastatistics/index.html
- International Initiative for Impact Evaluation - https://www.3ieimpact.org/

Academic Search Engines and Collections

The following professional research networks, which provide journal articles and other published documents, were searched for relevant publications:

- Google Scholar
- ResearchGate
- Academia

Grey literature Sources (including country-specific sources)

The following grey literature sources were searched from our three selected countries to obtain relevant information from unpublished literature.

Table 4: Grey Literature Sources

Country	Source
Bangladesh	Bangladesh Health Observatory
	Bangladesh Health and Injury Survey
Uganda	Disaster Preparedness Office, Uganda
	Ministry of Health, Uganda
	Makerere University School of Public Health
South Africa	Statistics South Africa
	National Sea Rescue Institute
	National Injury Mortality and Morbidity Surveillance Project
Others	Africa Check
	DesInventar – United Nations Office for Disaster Risk Reduction
	District Police offices, marine police, and fire/rescue detachments

Other methods for identifying relevant research

These supplementary search methods were used to obtain any additional publications:

- The authors who had only published an abstract were contacted to conduct a comprehensive search for unpublished or "grey literature."
- The references of all the included articles were read to identify any relevant cited articles not identified in the review.

Search Process

In the title and abstract screening, only articles focusing on aspects of drowning that could influence the incidence, prevalence, or risk of drowning and near drowning were selected. Country-specific data collection tools, including VA instruments, processes, reports, and international guidelines and reports from the above-mentioned websites and databases, were accessed to identify, export, and collate relevant data for each country on drowning data collection for comparison and analysis.

Records Obtained

The database search was conducted from 8 August to 30 September 2023. A total of 11,455 publications were identified. The number of records obtained from each database or source is presented in **Table 5** below.

Table 5: Results of database/source search

No.	Database/Source	Result
1	Medline	3,516
2	EMBASE	5,939
3	Web of Science & Social Sciences Citation Index	1,686
4	Websites and Databases of International Organisations	2
5	Academic Search Engines and Collections	150
6	Grey Literature Sources	162
Total		**11,455**

Management of Records

Mendeley Reference Manager Software (Mendeley, 2023) was used to manage and find duplicates of the obtained results. A total of 4004 duplicates were excluded, and the remaining publications were included for screening.

Screening Process

Phase 1

The title and abstract of 7,451 publications were screened using the Rayyan Systematic Review tool (Rayyan, 2022). The World Bank's 'country classifications by income level' was used to determine whether the study had been conducted in an LMIC setting (WB, 2022). Two reviewers independently screened each record, and the records that did not meet the inclusion criteria were removed. The project leads discussed publication disagreements, and if consensus could not be reached, the publication was included for full-text review. Four hundred eighty-eight publications were selected for full-text screening.

Phase 2

All full-text publications that met the inclusion criteria were read and then retained or excluded. Two reviewers independently read each publication. A record of the decision for each publication was kept, and a list of the excluded publications, including the reasons for exclusion, was also made. The review included 119 journal articles and six reports (n=125).

The inclusion criteria of this review followed the framework reported by Arksey and O'Malley (2005), and the PRISMA Extension for scoping reviews (Tricco *et al.*, 2018) was followed to report the review results. **Figure 1** illustrates the PRISMA flow chart (Moher *et al.*, 2009) - developed as per the PRISMA criteria.

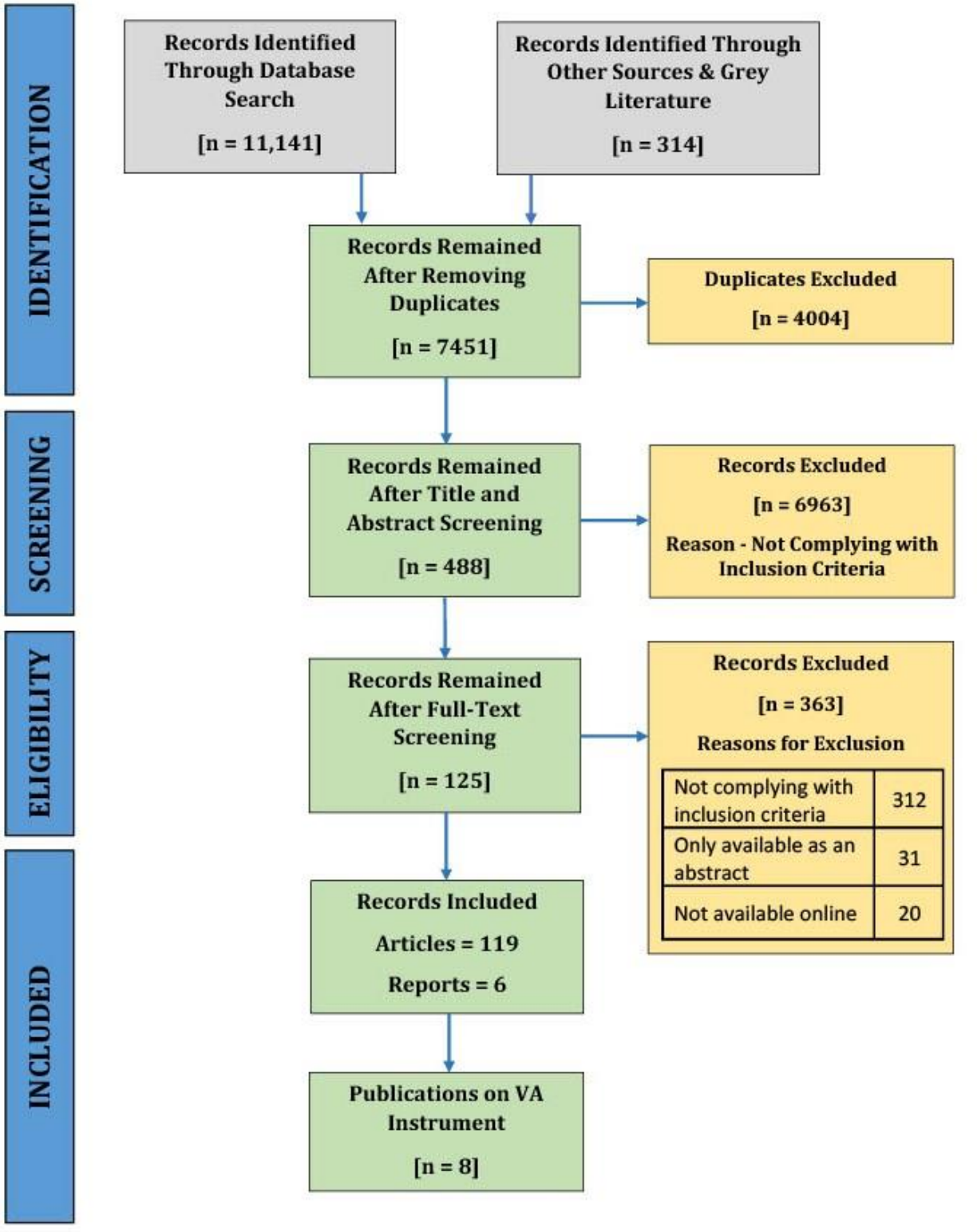

Figure 1: PRISMA Flow Chart – Criteria for article selection

Data Extraction

The following information was extracted from the 125 included publications, and the extracted data was saved in an Excel table.

- Article title
- DOI/Weblink
- Name of the first author
- Year of publication
- Country (e.g., China, Bangladesh, South Africa)
- City (e.g., Dhaka, Beijing, Cape Town)
- Study setting (e.g., Urban, Rural, Coastal)
- Aim of the study
- Study design
- Study duration (including start-end date)
- Study population size
- Study target sample size
- Demographic details of fatalities (e.g., age, gender, occupation)
- Any high-risk groups (e.g., Children, Fishermen)
- Number of cases/deaths/injuries/mortality rates (Incidence/Prevalence and Raw Number)
- Causes of death or injury (e.g., Suicide, Fatal Drowning)
- Type of water source (e.g., River, Sea, Swimming Pool, Bathtub)
- Any other data collected (Causes and Circumstances)
- VA tool and other data collection tools used
- Analyses performed (Qualitative or Statistical)
- Reporting person/organisation/the source of data (e.g., community individual, professional organisation)
- List of organisations involved
- Other actions taken (e.g., Communication reporting chain to government, Health services, NGOs, communities)
- Limitations
- Conclusions & Recommendations

RESULTS

Results - General

Published Year

One hundred and nineteen articles and six reports that were selected for the review covered a period of about 11 years (1st January 2012 – 30th September 2023) (see **Figure 2)**. During this period, two important reports were also published by WHO, viz. *Global Report on Drowning* (2014), and *Preventing Drowning - An Implementation Guide* (2017). It is evident that the number of publications arising from LMIC settings increased since the publication of the *Global Report on Drowning*.

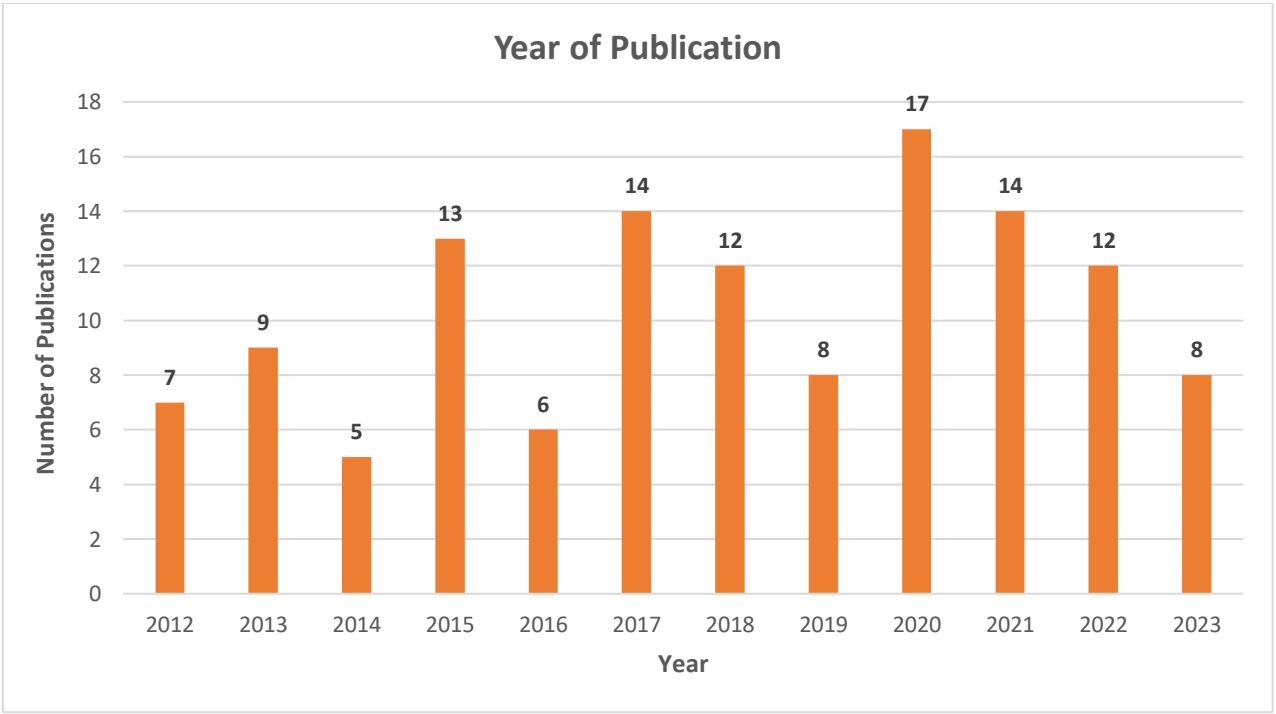

Figure 2: Number of publications based on the year of publication

Income Level

Of the 125 publications, 75 (the majority, 60%) came from lower-middle-income economies, 39 (31%) from upper-middle-income economies, and eight (7%) from low-income economies. The remaining three (2%) publications reported global data, which included countries with low-income economies, lower and middle-income economies, and high-income economies (see **Figure 3**).

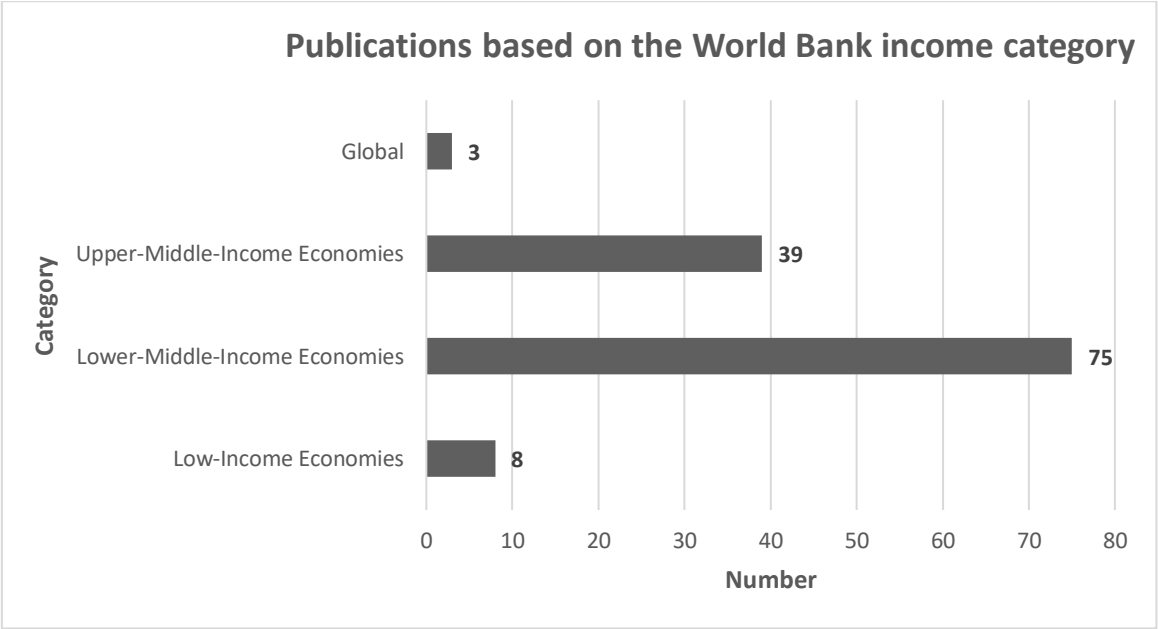

Figure 3: Number of publications based on the income category

Some countries with low-income economies included Malawi and Uganda, and countries with lower-middle-income economies included Bangladesh, India, and Pakistan. Countries with upper-middle-income economies included China, Iran, and South Africa. In **Figure 4**, we have identified the top 10 LMICs with the highest number of publications**,** and **Figure 5** illustrates the global distribution of the included studies.

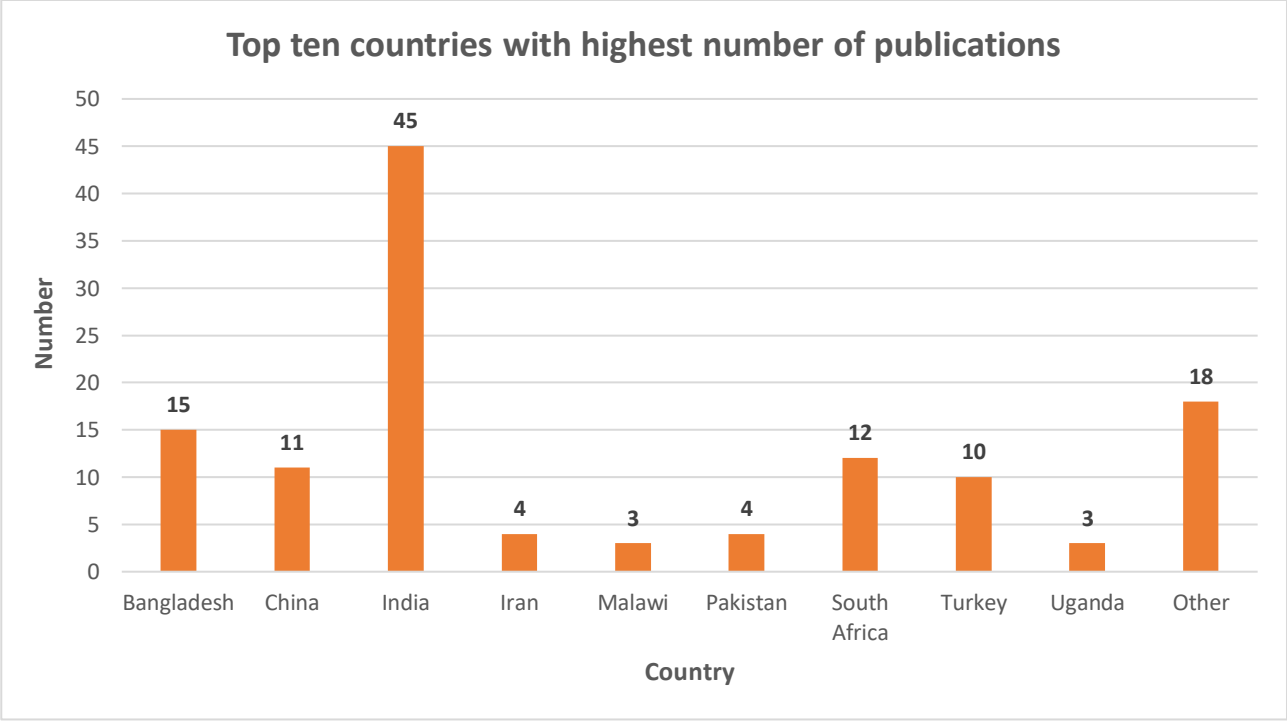

Figure 4: Top ten countries with the highest number of publications

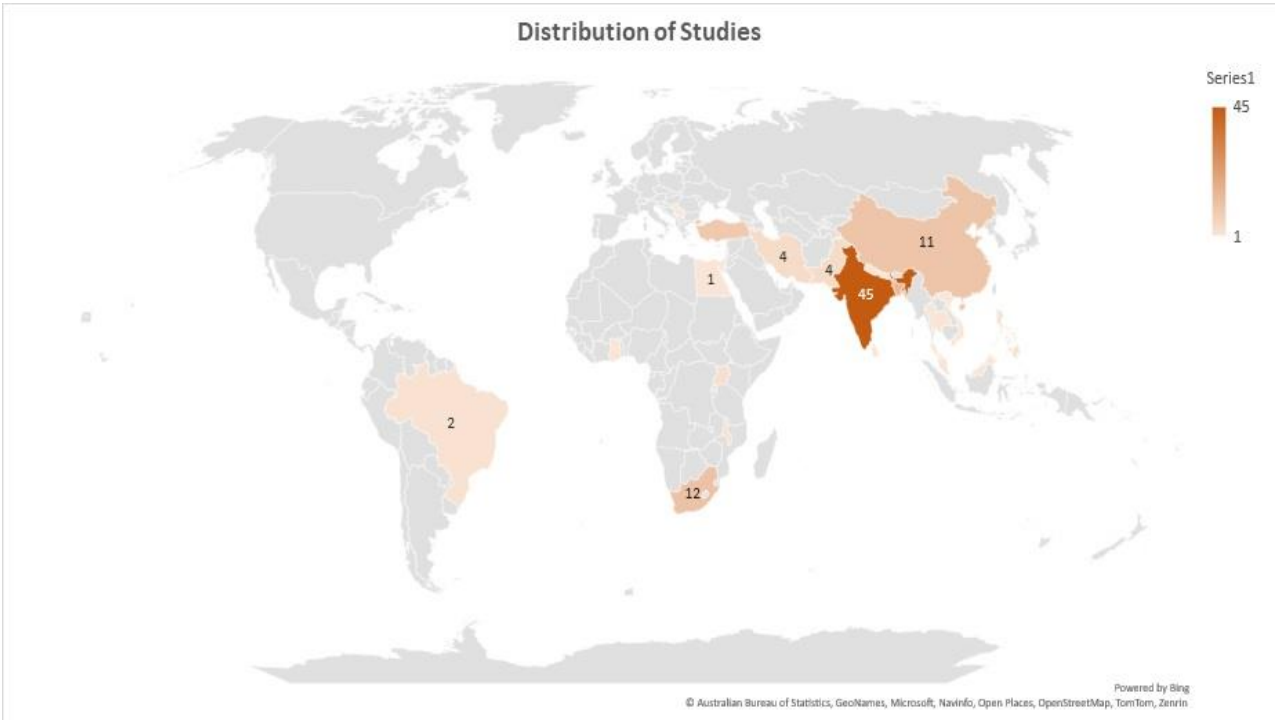

Figure 5: Global distribution of included studies

Study Setting

Out of 125 publications, 65 did not report the study setting or participant's living setting. Twenty-six provided information on two types of settings (rural and urban), 18 publications reported urban settings and 14 publications reported rural settings only (see **Figure 6**).

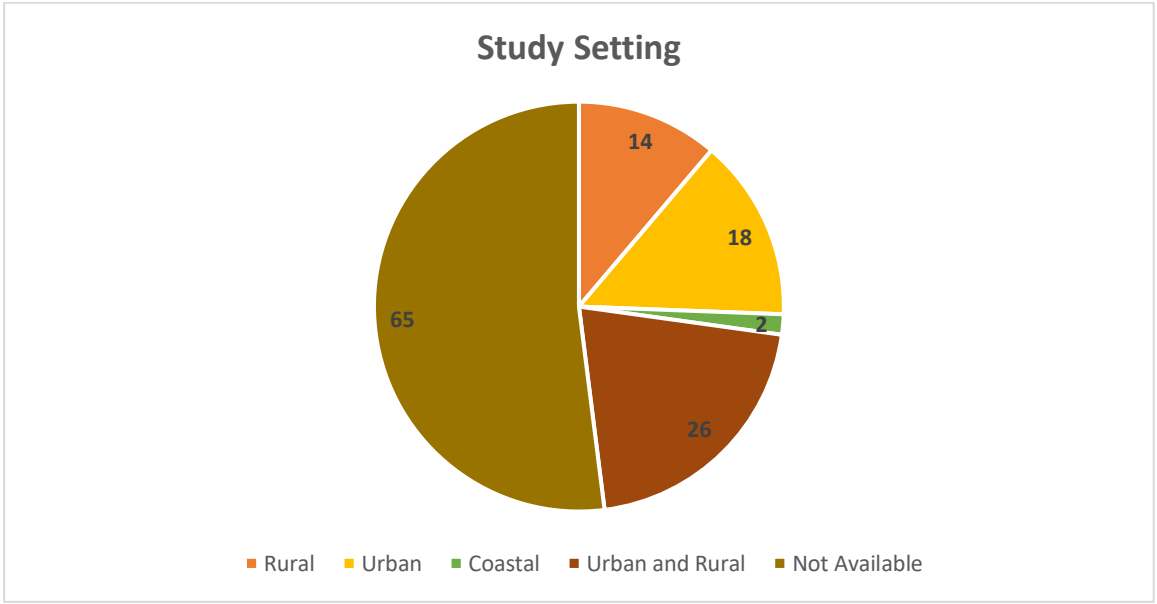

Figure 6: Study Setting

Study Duration

Of 125 publications, 30 reported their study duration between three and five years, and another 30 reported more than five years. Eleven studies reported a minimum period of up to six months, and another 11 studies reported seven to twelve months of study duration. For more details, see **Figure 7** below.

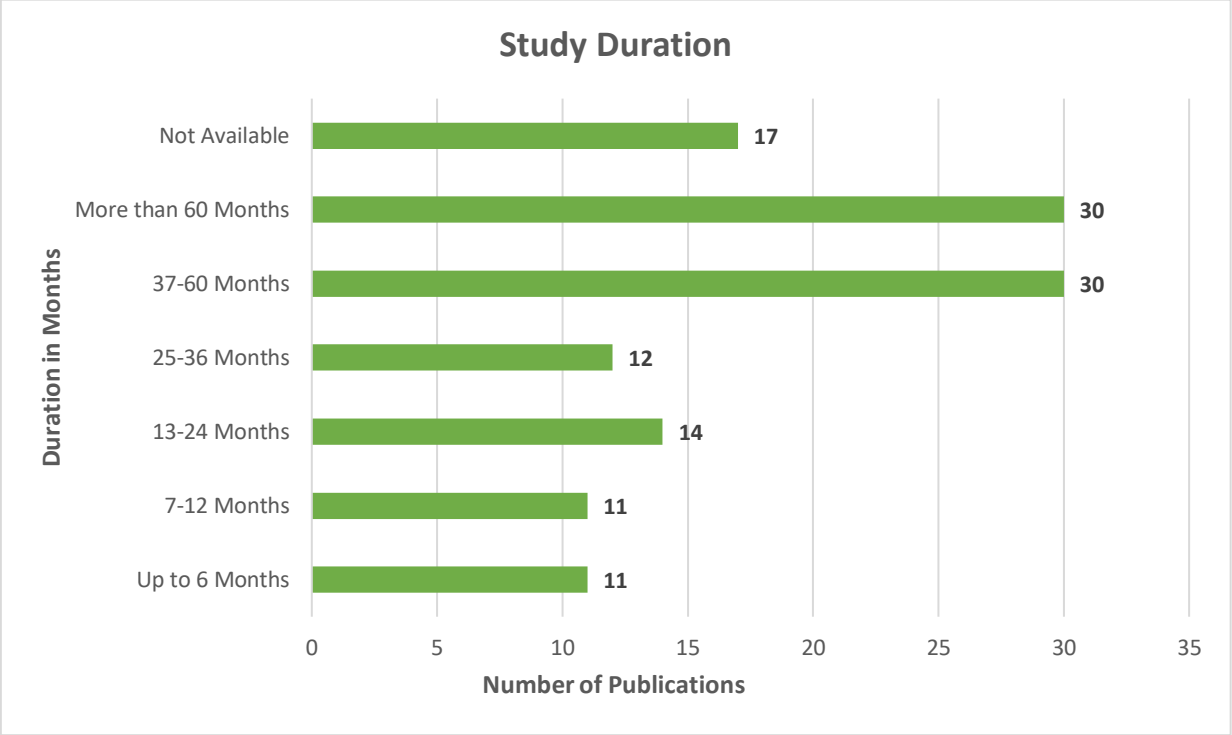

Figure 7: Study Duration

Type of water source

Out of 125 publications, 60 reported details of the water source where the victim experienced drowning. In these 60 publications, the authors reported a total of 30 different water sources. The most common water source was rivers (41), followed by ponds (29), lakes (27), sea (19), and canals (17). Water sources such as sewers, house water tanks, and agricultural and animal water supplies were reported in a few publications. We have grouped these latter water sources under the broad category of "other". **Figure 8** illustrates the different types of water sources reported in the publications.

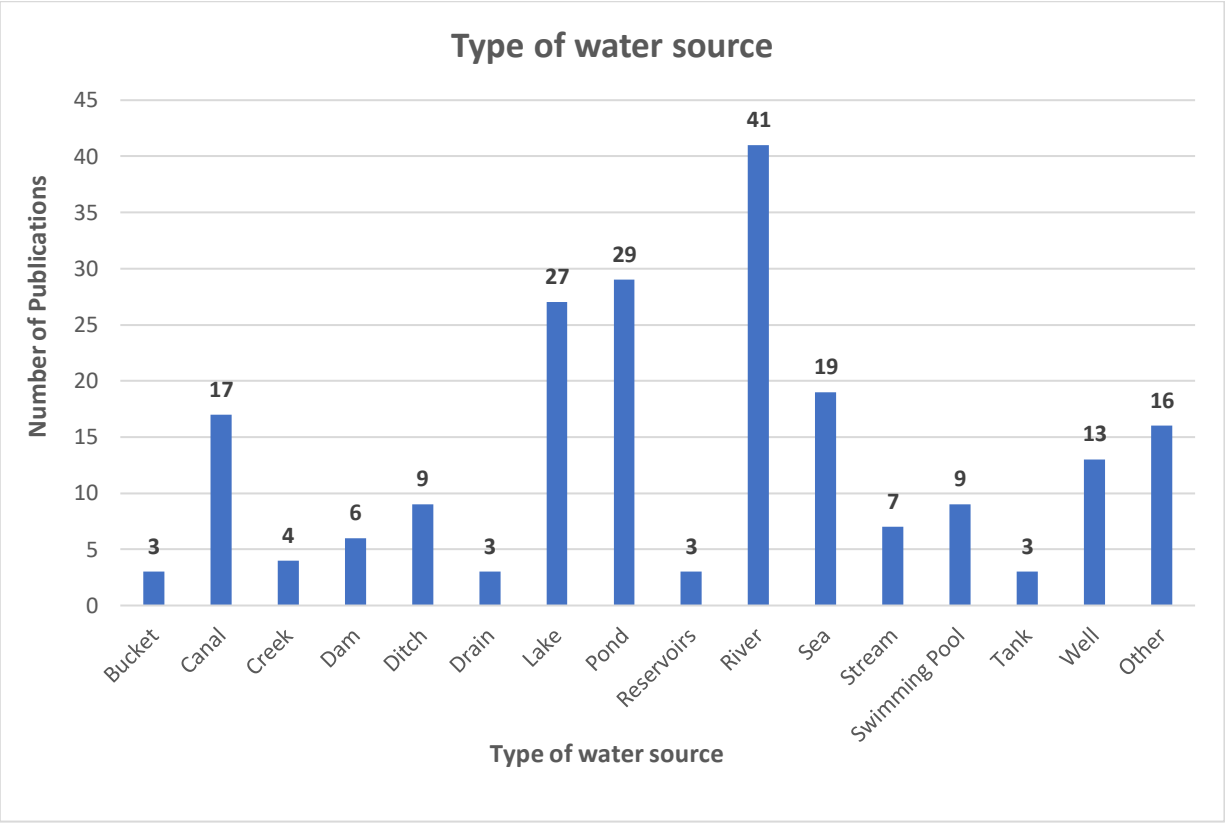

Figure 8: Type of Water Source

Affected Population Groups

Of the 125 publications, 84 identified 13 different affected population groups that are at risk of drowning (see **Table 6**). Among these groups; children, infants, and adolescents (descending order) seem to carry the highest burden of fatal and nonfatal drowning. The standard age classifications declared by the WHO (Ahmad *et al.*, 2001; NIH, 2013) were not followed in many publications when reporting data related to these population groups at risk. Hence, we grouped children and adolescents under the broad age range of 1 – 19 years when reporting the review results (**Table 6).**

Table 6: Number of publications reporting fatal and nonfatal drowning of population and occupational groups

Age / Category	Population Group	Number
0 – 4 Years	Infants	17
5 – 19 Years[2]	Children	66
	Adolescents	16
Over 19 Years	Young Adults	1
	Women	4
	Elderly	4
	Adults in General	4
Special Categories	Fishers	5
	Persons with Epilepsy	5
	Persons with Mental Health Disorders	2
	Tourists	2
	Students	1
	Refugees	1
	Rural Population	1
	People living near open water sources	1
	No Population Group Reported	41

[2] WHO's age group definition:

https://www.who.int/health-topics/adolescent-health#tab=tab_1

https://seer.cancer.gov/stdpopulations/world.who.html

Results – Objectives Specific

Objective 1: Types of drowning data reported from LMIC settings

Data collected during the study

We reviewed the content of 125 publications under four categories: i) socio-demographic details, ii) cause of drowning, iii) circumstances surrounding drowning, and iv) other information (see **Table 7**). We predetermined the first two categories, and the latter two emerged during the review process. We provide the findings of these categories below.

Table 7: Type of Data Collected

Category	Type of Data Collected	Details | Examples	No. of Publications
Socio-demographic details	Age	Victim or Caregiver	121
	Gender		120
	Civil Status		14
	Economic Status		14
	Occupation		15
	Education Level		15
	Ethnicity		10
	Religion	Victim	7
	Language		2
	Monthly Income		2
Cause of drowning	Intentional and unintentional drowning		111

	Area of the House / Study Setting	Urban, Rural, Coastal	60
	Location	At the Water Source, Hospital or House	17
	Source of Water	Rivers, Sea, Wells, etc.	60
	Presence of Warnings Signs at Water Source		2
	Distance to Water Source		9
	Season of the Year		20
	Time of the Year		19
	Time of the Day		18
	Natural Hazard Disasters		1
	Swimming Ability	Victim	4
	Presence of a Caregiver or Parental Supervision		6
	Health Care Service Availability		11
	Medical History	Victim	12
	Activity Before Drowning	Risky Behaviour at the Water Source	11
	Alcohol or Substance Use		3
Other Information	Outcome: death (fatal) and injury (nonfatal)	Reported by the Authors	25
	Death Registration		1
	The Incidence Reported to the Police Station		1

Socio-demographic details: Of the 125 publications, 11 provided information on the victim's religion, language, and monthly income, and the remaining provided information on the victim or caregiver's age (121), gender (120), civil status (14), occupation (15), education (15), and ethnicity (10).

***Cause of drowning*:** We found authors reporting two main causes for drowning; "intentional" or "unintentional"/"accidental". Some authors also reported the cause of drowning as "unknown" if the exact cause could not be identified. The intentional drowning included cases of suicides (31) and homicides (5), while unintentional drowning (101) included accidental incidents.

Figure 10 illustrates the number of publications which reported these causes. Nine publications reported only the fatal and nonfatal drownings caused by intentional actions while 79 publications reported only the fatal and nonfatal drownings caused by unintentional actions. Twenty-two publications reported the two possible causes as well as "unknown". Fourteen publications did not provide any information on what caused drowning.

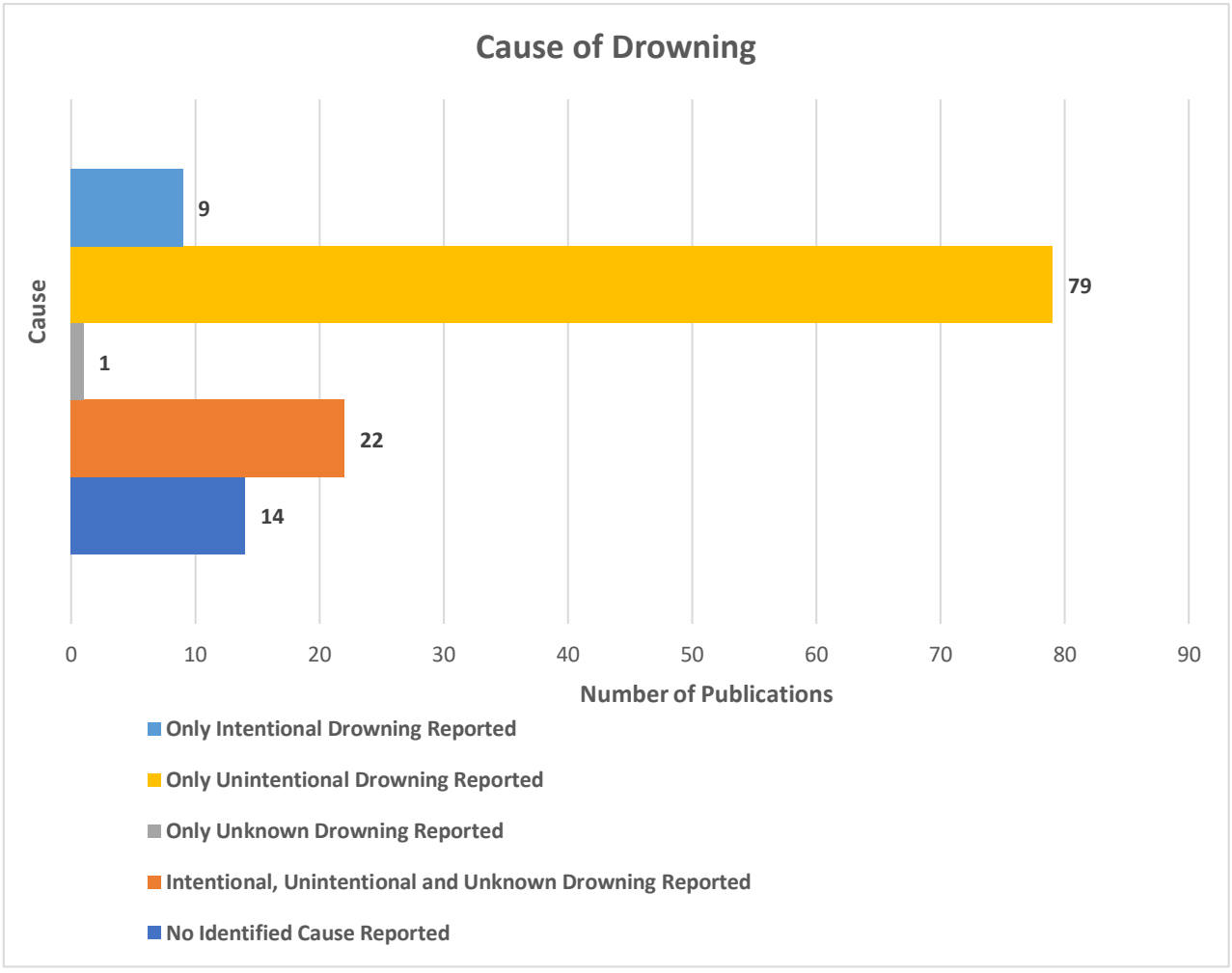

Figure 9: Cause for fatal and nonfatal drowning

Circumstances surrounding drowning: Another way to understand the cause of fatal and nonfatal drowning in LMIC settings is also through the lens of 'circumstances' surrounding deaths or injuries (Ray-Bennett, forthcoming; Jonkman and Kelman, 2005; Paul, 2020; Buyinza Mugeere, Oporia and Kobusingye, 2022)[3]. These authors used nine variables to understand causes and circumstances surrounding deaths, and they are i) medical cause of death, ii) activity before death, iii) timing of death, iv) gender, v) age, vi) lack of judgement of the deceased (Jonkman and Kelman, 2005) vii) mechanism (indoor/outdoor), viii) location, and ix) attempt to take safety measures by the deceased (Ray-Bennett, forthcoming; Paul, 2020). These variables informed the review process.

Based on the content review of 125 publications, we found 15 circumstances surrounding drowning (see **Table 7**). Of these, 12 circumstances are unique to drowning and not identified by the abovementioned authors (See **Table 8** below).

Table 8: Circumstances surrounding fatal and nonfatal drowning

Circumstances surrounding fatal and nonfatal drowning	Area of the house / Study setting	60
	Source of water	60
	Season of the year	20
	Time of the year	19
	Medical history	12
	Healthcare service availability	11
	Activity before drowning	11
	Distance to water source	9
	Presence of a caregiver or parental supervision	6
	Swimming ability	4
	Alcohol or substance use	3
	Number of children in the family	3
	Presence of warning signs at water source	2
	Natural hazard disasters	1

[3] Paul (2021), Jonkman and Kelman (2005) and Ray-Bennett (forthcoming) studied circumstances of deaths in a disaster context.

Other information: Twenty-five publications provided details on outcomes of drowning incidents as only fatal (16), only nonfatal (3) or both fatal and nonfatal (6). Based on the available information, for the rest of the 100 publications, the reviewers had to decide whether the outcome of drowning incidents is only fatal (74), only nonfatal (2) or both fatal and nonfatal (24).

Overall, according to both the authors' and reviewer's decisions, 90 of the 125 publications reported data on fatal drowning, 30 reported data on both fatal and nonfatal drowning, and five publications reported data only on nonfatal drowning (see **Figure 9**).

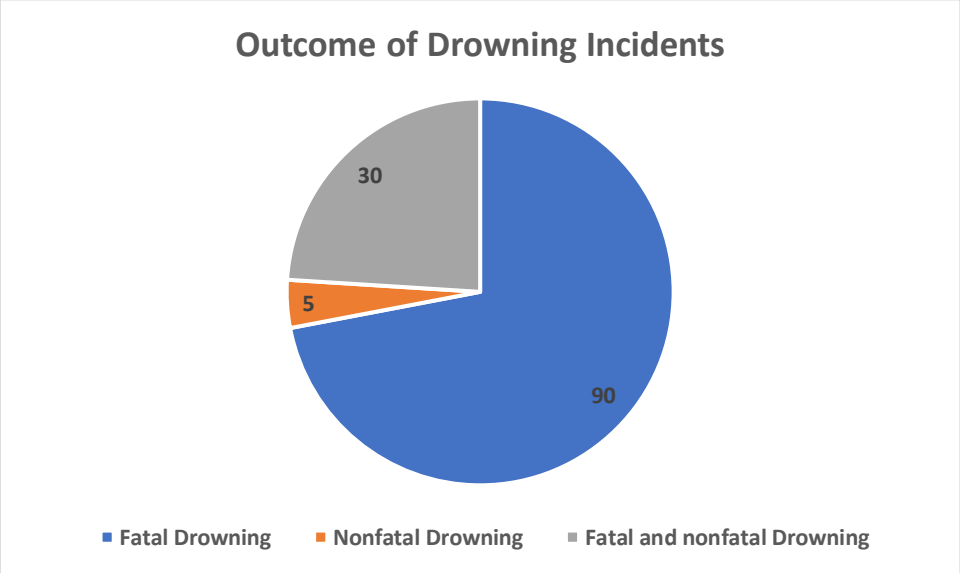

Figure 10: Outcome of the drowning incident

Objective 2: The methods employed in LMIC settings to collect drowning data and identify both the opportunities and challenges of the processes

Source of Data

Of 125 publications, 79 used secondary data, 45 used primary data, and only one study used primary and secondary data sources (see **Figure 11**). This means the majority (63%) of the studies used secondary data sources to obtain data on fatal and nonfatal drowning. These sources included autopsy records (30), national surveillance databases (15), and police and hospital records (7).

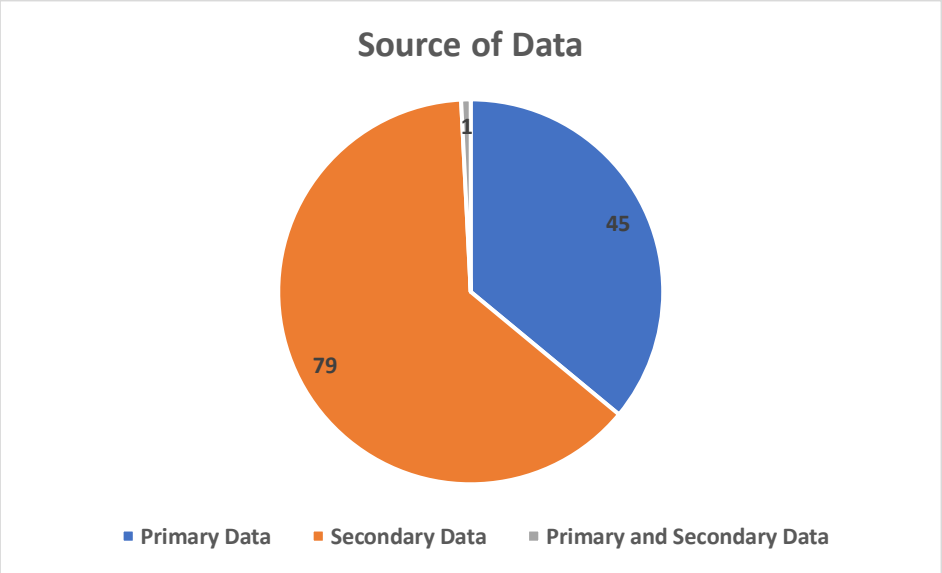

Figure 11: Different Sources of Data

Data Collection Methods

Of 125 publications, 122 used quantitative methodology and methods and only three used qualitative methodology (see **Table 9**). Of the 122 publications, 42 used primary data, 79 used secondary data, and one study used both primary and secondary data.

For the primary data (42), authors used quantitative methods such as (in descending order) cross-sectional (20), case series (16), case-control and prospective cohort study (2 each), and quasi-experimental and nested case-control (2 each). For the secondary data (79), the authors used two types of methods: reviews (49) and case reports (30). One quantitative study combined primary and secondary data using a review and cross-sectional method.

Three qualitative studies used primary data, and the authors used in-depth interviews, key informant interviews, structured observation, focus group discussions, content analysis, and photovoice interviews.

Table 9: Types of data collection methods employed to collect drowning data

<table>
<tr><th>Type of Data</th><th>Methodology</th><th colspan="3">Study Design and Method</th><th>Number of Publications</th></tr>
<tr><td rowspan="6">Primary Data</td><td rowspan="6">Quantitative</td><td>Experimental study</td><td>Non-randomised</td><td>Quasi-experimental</td><td>1</td></tr>
<tr><td rowspan="5">Observational study</td><td rowspan="2">Analytical study</td><td>Nested case-control</td><td>1</td></tr>
<tr><td>Case-control</td><td>2</td></tr>
<tr><td rowspan="3">Descriptive study</td><td>Case series</td><td>16</td></tr>
<tr><td>Prospective cohort study</td><td>2</td></tr>
<tr><td>Cross-sectional</td><td>20</td></tr>
</table>

	Qualitative	_	_	Key informant interviews, focus group discussions and community walkthroughs	1
		_	_	In-depth interviews and focus group discussions	1
		_	_	Content analysis, photovoice interview and structured observation	1
Secondary Data	Quantitative	Observational study	Descriptive study	Case reports	30
		_	_	Review of reports	49
Primary and Secondary Data	Quantitative	_	_	Review and cross-sectional	1

Opportunities

Seventy-nine studies (the majority 63%) used secondary data sources to obtain information on drowning. Autopsy records, institutional data repositories and national-level databases were the most accessed secondary data sources. According to the reviewed data, countries with high incidences of accidental drowning have often relied on recorded mortality data to identify the risk groups, causes of death, and pattern of drowning over the years (Saunders *et al.*, 2019; Çaylan *et al.*, 2021; Huang *et al.*, 2022). This has also supported the health care facilities and governing bodies to make projections and especially prepare emergency services in areas which experience high rainfall, flooding and people have easy access to natural water bodies for their day-to-day activities (Turgut and Turgut, 2014; Işın and Peden, 2022). The studies which used hospital medical and death reports reported the importance of appropriate interventions and high-quality healthcare facilities, including well-trained healthcare staff in areas with high incidences of drowning to mitigate drowning-related injuries becoming drowning-related deaths (Nguyen *et al.*, 2020; Praveen, Kumar and Raghavendra, 2023).

Forty-two studies (33%) used primary data mainly to identify the circumstances surrounding drowning. These studies interviewed the immediate family members to identify the circumstances which led to the death of the deceased. The findings of these studies were also used to design interventions to educate adults on domestic drowning (e.g., infants and children), occupational groups which work on natural water bodies (e.g., fishers, ship workers) and increase awareness of recuse workers working in coastal areas who often associate with tourists (Murray and Carter, 2017; Gupta *et al.*, 2021).

Challenges

One of the significant challenges about the secondary data sources is the reliability of the recording mechanisms (Wang *et al.*, 2019; Nguyen *et al.*, 2020). The most common challenges were difficulties reaching rural settings, limited trained persons and recording materials, and the reliability of data providers. Several studies reported concerns related to police and hospital death records. Under-reporting and over-reporting were identified, which could lead to erroneous policy decisions.

The studies which collected primary data reported issues related to recall bias (Hossain *et al.*, 2015; Al-Mamun *et al.*, 2023). The family members/relatives could find it challenging to recall the incident and also feel sad due to the death of their family members. This could lead to inaccurate data.

Objective 3: Data collection instruments used and the minimum parameters collected especially for the VA instrument

Of 125 publications, 17 were selected for this objective because they used the VA or other instruments to capture the cause of death. Of these 17 publications, eight reported using VA instruments and nine used non-VA instruments. Of the eight publications, five used newly developed VA instruments, two used the standardised WHO VA instruments and one used an adapted version of the WHO VA instrument (see **Box 1**). While reviewing these publications, we gathered information on background, socio-demographics, and other supporting data related to fatal drowning, summarised in **Table 10** below.

Box 1: Eight VA Instruments

i) Newly developed VA instruments (4) and PHMRC (Population Health Metrics Research Consortium) shortened VA questionnaire (1)
ii) WHO standardised VA instrument 2016 (1)
iii) WHO Standard Child Verbal Autopsy Questionnaire (CVAQ) (1)
iv) Adapted version of the standard VA instrument from WHO and INDEPTH Network (1)

Table 10: Type of data reported by the publications which used VA instruments (n=8)

Category	Type of Data Collected	No. of Publications
Background Information	Mourning Period	1
	Place of Data Collection	2
	Province	3
	Setting (Urban/Rural)	5
Socio-demographic Details	Age	8
	Gender	8
	Ethnicity	1
	Civil Status	2
	Education Level	2
	Occupation	2
	Socioeconomic Quintile	1

Other Data	Place of Incident	3
	Time of Incident	1
	Source of Water	2
	Distance to Water Source	2
	Cause of Death	6
	Details of Accompanying Person	1
	Swimming Ability	1
	Received Medical Care	2
	Medical History	6
	Survival Status	3
	Risk Factors	2
	Vulnerability of Deceased	1
	Details of Responder	3
	Open Ended Questions / Narratives	4

Nine of the 17 publications used standard questionnaires or newly developed instruments (see **Box 2**). These included a questionnaire based on the Ped FACT textbook, the Bangladesh health and injury survey tool, WHO's disability assessment schedule, the Chinese National Health Commission and UNICEF drowning mortality among children under five questionnaire, and newly developed questionnaires. The same variables of background, socio-demographics, and other supporting data were used to review the instruments see **Table 11** below. The details of these publications are available in **Appendix 1**. Further information is presented below under the heading 'minimum parameters'.

Box 2: Other Nine Instruments

i) Questionnaire (based on Ped FACTs textbook) (1)
ii) The Pak - NED tool (adapted from CDC) (1)
iii) Bangladesh Health and Injury Survey tool (BHIS) (1)
iv) WHO Disability Assessment Schedule (1)
v) Chinese National Health Commission and UNICEF Drowning Mortality among Children Under 5 Questionnaire (1)
vi) Newly developed questionnaires (4)

Table 11: Type of data reported by the publications which used other instruments (n=9)

Category	Type of Data Collected	Details | Examples	No. of Publications
Background Information	Place of Data Collection		2
	Province		1
	Area of the House / Study Setting	Urban, Rural, Coastal	5
Socio-demographic Details	Age	Victim or Caregiver	9
	Gender		8
	Civil Status		3
	Socioeconomic Quintile		4
	Occupation		4
	Monthly Income		1
	Education Level		7
	Ethnicity		1
	Number of Children in the Family		2
Other Supporting Data	Place of Injury or Death	At the Water Source, Hospital or House	3
	Time of Incident		2
	Source of Water	Rivers, Sea, Wells, etc.	2
	Distance to Water Source		1
	Fatal or Nonfatal drowning		2

	Intentional or Unintentional Drowning		1
	Details of Accompanying Person	Parent, Friend, Other Family Member	2
	Swimming Ability		1
	Medical History		5
	Risk Factors		3
	Circumstances		1
	Details of Responder		4
	Accidental Injury Safety Education		1

Minimum parameters collected, especially for the VA

For this review, 'minimum parameters for the VA' were understood as variables consistently used by the authors (Peden, Franklin and Clemens, 2019). For this, we reviewed the eight publications that used the VA instruments. We found 25 variables (see **Table 10**).

Background information: Five studies captured the setting (rural/urban), and two other interesting variables were noted by a couple of publications: the time to collect data (between two weeks and six weeks for fatal drowning) and the time taken to gather data (minimum 30 minutes and maximum 3 hours).

Socio-demographic details: All the selected studies consistently collected age and gender variables. Two studies each collected educational level, civil status and occupation, while one study collected the socio-economic quintile.

Other information: Six studies captured the causes of death and the medical history variables. Three studies captured the place of the incident and survival status. Four studies used the open-ended questions/narratives variables.

Objective 4: Information on organisations or individuals whose work has identified challenges and opportunities in using VA instruments to collect context-specific and modifiable risk factors for injury deaths in LMIC setting

As mentioned above, eight publications used the VA instruments. Of these, only two studies used the VA instrument to study fatal drowning among children. These are: Razzak *et al.*, (2013) and Dandona *et al.*, (2019).

Razzak *et al.* (2013) used the child VA questionnaire (CVAQ) to study the fatal drowning burden among children under the age of 5 in Pakistan and conducted demographic and health surveys in Pakistan. **Dandona *et al.*,** (2019) used the Population Health Metrics Research Consortium (PHMRC) shortened VA questionnaire for interviews to report on the incidence of fatal drowning and related contextual factors in children from a population-based study in the Indian state of Bihar.

The remaining six studies used the VA instrument to study the pattern of death casualty in a large sample size of people with epilepsy and risk factors, all causes of death, cause of death among people with convulsive epilepsy, and cause of death among HIV, cerebrovascular disease, diabetes mellitus, and interpersonal violence; nature and intent of injuries across gender, age and socio-economic status; and external causes of death.

Challenges

Seven authors of these eight publications identified the challenges of using VA instruments. A summary is provided below (also see **Table 12**).

According to **Weldearegawi *et al.* (2013),** the validity of the cause of death ascertained using VA is affected by various methodological and conceptual factors like the design and content of the questionnaire, the timing of the interview, the skills of interviewers, the respondents identified and the approach used to derive the probable cause of death from VA data. The validity and reliability of VA vary for varying causes of death and age groups. Physician review, the commonest method for interpreting VA data, enables the estimation of population-level underlying causes of death with reasonable validity. Despite this, reliability is a major problem with this approach. Another limitation of the physician review approach is that a diagnosis may be affected by the physician's prior knowledge of local epidemiology. It has been shown that physician reviewers will not readily code diseases not expected in certain demographic groups and geographic areas. In some instances, physician reviewers show a preference for highly specific diagnoses, tending to make an unsubstantiated selection of a single cause even if multiple causes are indicated; such nuanced interpretation introduces bias, particularly for less obvious causes of death (Weldearegawi *et al.*, 2013).

Razzak *et al.* (2013) used the child VA questionnaire (CVAQ) in Pakistan, and they reported recall and reporting bias and misclassification of cause of death as some of the challenges. The authors mentioned that the specific question in the instrument, "Did he/she die from injury or accident?" is likely to identify the immediate deaths due to injuries and will miss injury deaths occurring up to 30 days post-event, which is the current definition of injury mortality.

Ding *et al.*, (2013) used a survey and VA instrument and mentioned that a more detailed VA is needed when exploring the pattern of death of people with epilepsy. The instrument was not descriptive enough. It requires descriptions of the death by witnesses so that more evidence can be gathered.

Alonge *et al.* (2017) used the VA instrument in Bangladesh - one of the largest population-based injury studies in LMIC. The authors reported that the VA data might be subject to recall bias because the information was self-reported. Minor injuries might have been differentially recalled, leading to an underestimation of the nonfatal injury morbidity rates. Although the study specified a case definition for injuries that conformed to the ICD-10 causes of death classification, and the study questionnaires were based in part on the WHO standards for VAs, some injuries and fatal outcomes could still have been misclassified because of the questionnaires and the absence of a proper VA study. In addition, other information bias and data collection or entry errors, including information on dates and gender, could have further led to misclassification of injuries by age and gender. Although missing data and incomplete records were not significant for this study, missing records for fatal and nonfatal injury outcomes would have affected the study's ability to estimate rates with precision and accuracy.

Gelaye *et al.* (2018) noted difficulties in correctly extracting all the necessary data items, particularly for details of injuries contained in narratives. Calculating Kappa statistics was important to determine the agreement between two physicians in assigning the causes of deaths, which was not practised by the authors.

Dandona *et al.* (2019) used the Population Health Metric Research Consortium shortened VA questionnaire in India. According to these authors, the tool was not designed to capture context or risk factors for drowning deaths per se. According to the authors, this has been a major limitation of the VA questionnaire.

SAMRC (2020) in South Africa used VA interviews using the three questionnaires from the WHO 2016 tool. They found that the correspondence between the doctor-reviewed cause of death and Inter-VA5 most probable cause data indicates room for improvement. They recommended shortening the VA questionnaires. The time to complete a questionnaire varied according to the demographic of the decedent. Interviews regarding adult male decedents took the least time. Children and females took

the longest, especially where maternal deaths were concerned. When documents such as the death certificate and Road to Health (RTH) cards were available, it increased time spent in the household. Including the time taken for initial contact and consent, a single interview could take three hours, depending on the factors mentioned. Regarding the completion time for the questionnaire only by the next of kin/carer, it generally took between 30-45 minutes for death for an adult male, while it took 45 – 60 mins for an adult female or child. The authors recommended investigating the performance of all the items in the VA questionnaires to assess if there are opportunities for item reduction.

Table 12: Challenges Using the VA Instrument

Validation bias	• VA instrument for people with epilepsy
Reliability bias	• Physicians have more difficulties arriving at diagnoses for deaths caused by injury of undetermined intent. • Physicians review can be affected by local epidemiology
Recall and reporting bias	• Questions related to clinical details could be intimidating and inappropriate for the respondents to recall and report accurately
Information bias	• Misclassification of cause of deaths • Minor injuries difficult to diagnose • The VA instrument for epilepsy is not descriptive • The VA instrument is not designed to capture context or risk factors for drowning • Difficulties in extracting data items of injuries covered in the open narratives of the VA instrument
Misclassification bias	• Due to the variations in subjective interpretation
Missing records	• Missing records for fatal drowning outcomes affect estimate rates with precision and accuracy
Time consumption	• The VA questionnaire is long and can be time-consuming. When there is a death certificate, the interview time increases (up to 3 hours).

Opportunities

Five of the eight publications identified opportunities for using the VA instrument. A summary of these is provided below.

According to **Razzak *et al.*, (2013),** the VA is the most reliable method in the absence of a functioning vital registration and validation system. VA instruments perform well for injury deaths as one broad category, with high sensitivity, specificity, and positive predictive value compared to hospital records and death certificates. Standardised VA instruments by WHO and others have shown reasonable sensitivity and specificity for childhood deaths, too.

According to **Weldearegawi *et al.*, (2013),** in countries where registration of vital events is non-existent, and the proportion of people who die at home without medical care is high, VA is ideal for identifying causes of death. As of 2013**,** according to these authors, VA remained the best available approach in communities where most deaths occur at home and is used in 35 sites, primarily in Africa and Asia.VA data are generated through retrospective questioning of the caretaker for the deceased in surveys or demographic surveillance systems. The VA method is generally recommended to obtain a population-level estimate of causes of death without a medical recording system.

According to **Alonge *et al.*, (2017),** the VA instrument can provide an all-inclusive socio-demographic assessment of fatal and nonfatal injury outcomes in LMICs**.** The findings are also useful for accurate estimation of and raising awareness about the true nature of the burden of injuries in LMICs.

According to **Gelaye *et al.*, (2018),** the VA instrument enabled the timely measurement of changing trends in cause-specific mortality to provide policymakers with the much-needed information to allocate resources to appropriate health interventions.

Dandona *et al.*, (2019), used the Population Health Metrics Research Consortium (PHMRC) shortened VA questionnaire, and the interviews highlighted the circumstances surrounding the drowning event, which could provide a starting point for prevention and intervention opportunities.

DISCUSSION AND CONCLUSION

Types of Drowning Data (Objective 1)

Whilst reviewing 125 publications, we found drowning data is reported around socio-demographic details, causes and circumstances surrounding drowning, and other details. Most notably, 101 publications reported drowning as unintentional, 36 reported intentional, and 22 reported both intentional and unintentional. These findings indicate that the majority of drowning is unintentional (80%) and have implications for policy and practice to reduce it at local levels.

We found 30 different water sources that put people at risk of drowning. The most common water sources were rivers, ponds, lakes, seas, canals, wells, ditches, swimming pools, dams, creeks, tanks, buckets, reservoirs and other sources, including sewers, house water tanks, agriculture and animal water supplies. These findings are consistent with the WHO's (2014, p.12) drowning risk framework, which states, “Wherever there is water there is a threat of drowning”. In this aspect, understanding and respecting water sources and promoting education around water safety since many villagers do not have access to hospitals and providers of Western medicine can lead to minimising drowning risk (Mateen *et al.*, 2012) indoors and outdoors. Education and water safety measures may include (although are not limited to) putting up fences around pools and ponds, draining ponds, filling canals and ditches, supervising swimmers, special precautions during monsoon season, wearing lifejackets, inflatable water wings and other floatation devices, and instructions on showering instead of bathing are potentially life-saving (Mateen *et al.*, 2012). Still further, educating people living in waterside areas regarding the risk of drowning and treating people with epilepsy and depression appropriately may modify the drowning risk and injury (ibid).

Also, we found that 13 different population groups are at risk of drowning. Of these 13, infants, children and adolescents carry the high burden of fatal drowning. This finding is consistent with WHO’s drowning risk framework’s high-risk group. We also found ten other different groups who are also at high risk of drowning; this includes women, the elderly, adults in general, fishers, tourists, students, people with mental health disorders, people with epilepsy and refugees. Based on this finding, we recommend that WHO’s drowning risk framework be revisited to include the emerging high-risk groups so that local and national governmental and non-governmental organisations are informed to develop context-specific interventions.

Methods employed in the LMIC settings to collect drowning data and identify opportunities (Objective 2)

We found that the majority (63%) of the studies used secondary data to obtain data on drowning. Quantitative methodology and methods are largely used to gather these data. Only three studies used qualitative methodology and methods. There is an opportunity for the social science of the neglected public health areas to employ various sociological and anthropological qualitative research methods (e.g., in-depth interviews, structured observation) to capture the causes and circumstances of drowning. Most importantly, these methods can play a vital role in capturing the circumstances surrounding nonfatal drowning. Therefore, there is an opportunity for researchers, practitioners and the Royal National Lifeboat Institution to implement and advocate qualitative research methods.

Furthermore, sociological and geographical studies with a particular focus on class, gender and place can add further understanding of the vulnerable groups at the intersection of living with/at risk in LMIC settings. Without qualitative research methods, the actual burden of not only fatal but also nonfatal drowning cannot be understood. There is an opportunity to use a variety of qualitative research methods such as observation, narratives, and case reports (among others) to understand the burden of serious injury and lifelong disability that are not routinely collected in LMIC settings.

Data collection instruments used and minimum parameters collected especially for the VA instruments (Objective 3)

Of the selected studies, we found eight publications that used VA instruments and nine that used non-VA instruments. Of the eight publications that used the VA instrument, only two captured fatal drowning among children. This means that despite the increase in drowning publications after 2014, there have been no significant increases in understanding of the causes and circumstances of fatal drowning using the VA instrument. Furthermore, there has been no study that captured the circumstances of nonfatal drowning using the VA instrument. There is a scope for WHO and the Royal National Lifeboat Institution to promote change in this regard.

Nine publications used non-VA instruments, which is encouraging. Researchers and practitioners in this domain can develop original questionnaires to capture the causes and contextual circumstances surrounding fatal drowning and identify context-specific interventions. More such studies are needed to spark interdisciplinary studies to advance this neglected area of public health.

With regard to minimum parameters, we recommend 29 variables that can potentially capture the causes and circumstances surrounding drowning, which are: i) details of responder/s; ii) time for data collection (between two weeks and six weeks after the incident); iii) place of data collection; iv) age; v) gender; vi) educational level; vii) ethnicity; viii) religion; ix) occupation; x) vulnerability of the

deceased; xi) study setting or area of the house; xii) place of incident; xiii) time of the incident; xiv) season of the year; xv) survival status; xvi) cause of death; xvii) natural hazard disaster; xviii) water source; xix) distance of water source; xx) swimming ability; xxi) medical history; xxii) received medical care; xxiii) details of the accompanying person; xxiv) activity before drowning; xxv) presence of caregiver; xxvi) number of children; xxvii) alcohol or substance use; xxviii) presence of early warnings; xxix) health care service availability.

Most of these variables are consistent with the WHO's drowning risk framework's third component, 'where are the risks?'. However, the findings provide an additional layer of understanding on drowning risks and how they can be mitigated by understanding the seasonality of risk (time of the year) and promoting preparedness through effective early warning systems related to natural hazard disasters – among other measures.

Challenges and Opportunities of the VA tool (Objective 4):

We found five different VA instruments (see **Box 1** above) and six non-VA instruments (see **Box 2** above). The VA instruments are designed to capture the cause of death based on ICD 10 (see **Appendix – 3**) (WHO, 2016). But they are not intended for circumstances surrounding fatal and nonfatal drowning. This is one of the significant challenges of the VA instrument. This being said, the VA instruments have a section called 'open narrative' where contextual circumstances surrounding fatal drowning can be captured. Of these five instruments, only one study captured contextual circumstances to understand fatal drowning, which used the PHMRC-shortened VA instrument (see Dandona *et al.*, (2019). This finding indicates that the 'open narrative' section is underutilised. The authors likely gather data but filter this information out during publications, which is a cause for concern.

Contextual information is vital to developing case reports, which can provide a starting point for prevention and intervention opportunities (Dandona *et al.*, 2019). They can also lead to developing scenario planning and tabletop exercises for capacity building of responders and communities living with/at risk (Senge, 1990; Ray-Bennett, 2018). Dandona *et al.*, (2019) used open narratives to capture three different types of contextual information surrounding the fatal drowning of children aged 1 -14 years, and these contexts are: death while playing in the water; death while bathing in water; death while defecating. All these three contexts merit three unique and yet inter-connected interventions.

We recommend that researchers and practitioners using VA instruments should make use of the 'open narrative' so that we can better understand the actual burden of fatal drowning carried largely by the existing and emerging high-risk groups.

We recommend that the researchers and practitioners using VA instruments are aware of seven challenges identified in this review (see **Table 12**): i) validation bia; ii) reliability bias; iii) recall and reporting bias; iv) information bias; v) misclassification bias; vi) missing record; vii) time consumption.

We also recommend complementing VA with social autopsy (SA) instruments (*aka* VASA) to capture the circumstances surrounding drowning. SA is similar to VA but identifies the social, behavioural and health systems determinants for a particular cause of death (Waiswa *et al.*, 2012; Mahato *et al.*, 2018). Through a structured interview process, SA determines the non-biological causes of death to facilitate community diagnosis and identification of modifiable social and cultural factors that are attributable to death (Mahato *et al.*, 2018). SA has been largely used to identify factors related to maternal mortality, health promotion (Mahato *et al.*, 2018), and neonatal and child mortality (Koffi *et al.*, 2015; Johns Hopkins University, 2024). To the best of our knowledge, SA has not been used for fatal drowning[4]. There is scope for the Royal National Lifeboat Institution to develop an SA questionnaire to capture non-biological causes of fatal drowning using some of the circumstances variables and qualitiative research methods identified above (Objective 3).

[4] Using the keyword search 'social autopsy' (last 10 years, language - English), we searched Pubmed, CINAHL, EMBASE and Medline databases. We found 203 pieces of literature, and after removing duplicates, we shortlisted 74. In our second search using the keywords (social autopsy AND drowning), we found one publication (same publication in Pubmed and Medline) and after review, it did not meet the criteria.

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APPENDICES

Appendix 1: Data collection tools reported by the included publications

No.	Publication	Data Collection Tool	Description	Availability
1	(Ding *et al.*, 2013)	Newly Developed VA Questionnaire	Used a VA tool for People with Convulsive Epilepsy	Not Available
2	(Dandona *et al.*, 2019)	PHMRC shortened VA Questionnaire	The Population Health Metrics Research Consortium (PHMRC) shortened VA questionnaire.	Available
3	(Razzak *et al.*, 2013)	WHO Standard Child Verbal Autopsy Questionnaire (CVAQ)	Standardised questionnaire for estimating childhood mortality and morbidity.	Available
4	(Weldearegawi *et al.*, 2013)	An adapted version of the Standardized VA Questionnaire from WHO and INDEPTH Network	Structured VA questionnaire containing open and closed-ended questions	Not Available
5	(Alonge *et al.*, 2017)	Newly Developed VA Questionnaire	The questionnaire covered seven modules 1. household characteristics and socioeconomic census 2. birth history 3. household environment 4. death confirmation 5. injury morbidity	Available

			6. injury mortality injury mechanism	
6	(Jin *et al.*, 2022)	Newly Developed VA Questionnaire	The questionnaire is made up of three parts: (1) basic demographics, (2) medical history of epilepsy and treatment, and (3) survival status (alive or deceased).	Not Available
7	(Gelaye *et al.*, 2018)	Newly Developed VA Questionnaire	A VA form was developed to identify the causes of registered deaths.	Not Available
8	(SAMRC, 2020)	WHO VA Instrument - 2016	The WHO VA 2016 questionnaires, the most up-to-date forms available, were selected for use in the study	Available
5	(Halawa *et al.*, 2015)	Questionnaire (Based on Ped FACTs textbook)	The questions were developed using a PedFACTs textbook and an instructor's resource manual published by the American Academy of Paediatrics.	Not Available
6	(He *et al.*, 2015)	The Pak - NED tool (Adapted from CDC)	The tool was developed according to CDC guidelines and used to collect data on drowning events in emergency departments. The tool was used for the national surveillance study, Pakistan.	Not Available
7	(Hossain *et al.*, 2015)	Bangladesh Health and Injury Survey Tool (BHIS)	The BHIS is the main injury investigation directed at the public level in a developing country.	Not Available
9	(Barlas and Izci, 2017)	Newly Developed Questionnaire - Workplace Safety Survey	The questionnaire is made up of four parts: personal data, workplace environment, personal factors, and commuting factors.	Available
10	(Hoque *et al.*, 2017)	Newly Developed Questionnaire	Structured, pre-tested questionnaire and consisted of seven modules.	Not Available

11	(Khatlani *et al.*, 2017)	Newly Developed Questionnaire	Questionnaire based on guidelines for injury surveillance by the WHO	Not Available
12	(Rahman *et al.*, 2019)	Newly Developed Questionnaire	Questionnaire-based on ICD-10 Chapter XX	Not Available
16	(Wang *et al.*, 2020)	Chinese National Health Commission and UNICEF Drowning Mortality among Children Under 5 Questionnaire	The questionnaire was designed by the Chinese National Health Commission and UNICEF to gain information on children under five who died due to drowning.	Not Available
17	(Jagnoor *et al.*, 2021)	WHO Disability Assessment Schedule	The WHO Disability Assessment Schedule (WHODAS 2.0) is a unique practical instrument, based on the International Classification of Functioning, Disability and Health (ICF), that can be used to measure general health and disability levels, including mental and neurological disorders, both at the population level or in clinical practice, in a wide range of cultural settings.	Available

Appendix 2: WHO VA 2022 Tool – Details of Individual Questions Relevant to Drowning

Except for the Open Narratives all the questions are close-ended.

VA interviewer

(Id10010) [Name of VA interviewer]

(Id10010a) [Age of VA interviewer]

(Id10010b) [Sex of VA interviewer]

(Id10010c) [ID of VA interviewer]

Interview language:

Information on the respondent and background about interview

(Id10007) What is the full name of VA respondent?

(Id10007a) [What is the sex of VA respondent?]

(Id10007b) What is the age of VA respondent?

(Id10008) What is your/the respondent's relationship to the deceased?

(Id10009) Did you/the respondent live with the deceased in the period leading to her/his death?

(Id10012) Date of the interview

(Id10013) [Did the respondent give consent?]

(Id10011) Start time of the interview

Information about the deceased and vital registration

Information on the Deceased

(Id10017) What was the first or given name(s) of the deceased?

(Id10018) What was the surname(s) (or family name(s)) of the deceased?

(Id10019) What was the sex of the deceased?

(Id10020) Is the date of birth known?

(Id10021) When was the deceased born?

(Id10022) Is the date of death known?

(Id10023_a) When did (s)he die?

(Id10023_b) When did (s)he die?

(Id10023) When did (s)he die?

(Id10024) Please indicate the year of death.

Age in Days:

Age in Days:

Age in Years:

Age in Months:

The deceased person is a Neonate

The deceased person is a Child

The deceased person is an Adult

NEONATE was ${ageInDays} days old.

CHILD was ${ageInYears} years ${ageInMonths} months and ${ageInMonthsRemain} days old.

ADULT was ${ageInYears} years old.

[What age group corresponds to the deceased?]

How many days old was the baby? [Enter neonate's age in days:]

How many hours was the baby alive?

How old was the child? [Enter child's age in:]

[Enter child's age in days:]

[Enter child's age in months:]

[Enter child's age in years:]

[Enter adult's age in years:]

Age in Months

Age in Years

The deceased person is a Neonate

The deceased person is a Child

The deceased person is an Adult

The deceased person is a Neonate

The deceased person is a Child

The deceased person is an Adult

Age in days

(Id10008_check) It is not possible to select that the respondent is the child of the deceased and enter that the deceased is a neonate or child. Please go back and correct the selection.

(Id10058) Where did the deceased die?

(Id10051) [Is there a need to collect additional demographic data on the deceased?]

(Id10052) What was her/his citizenship/nationality?

(Id10053) What was her/his ethnicity?

(Id10054) What was her/his place of birth?

(Id10055) What was her/his place of usual residence? (the place where the person lived most of the year)

(Id10057) Where did the death occur? (specify country, province, district, village)

(Id10059) What was her/his marital status?

(Id10063) What was her/his highest level of schooling?

(Id10064) Was (s)he able to read and/or write?

(Id10065) What was her/his economic activity status in year prior to death?

(Id10066) What was her/his occupation, that is, what kind of work did (s)he mainly do?

(Id10061) What was the full name of the father?

(Id10062) What was the full name of the mother?

Open narrative

"Record detailed notes of response or audio record the response if the option is available. If needed, probe the respondent for additional details on when the deceased recognised symptoms, abnormalities, care sought, etc. Ask the respondent if any medical records from the time preceding death are available and record any relevant information. Some of the following questions may be repetitive or irrelevant to the respondent but they are very important in the COD assignment process."

(Id10476_audio) Thank you for your information. Now can you please tell me in your own words about the events that led to the death?

(Id10476) Thank you for your information. Now can you please tell me in your own words about the events that led to the death?

(Id10477) [Select any of the following words that were mentioned as present in the narrative.]

(Id10478) [Select any of the following words that were mentioned as present in the narrative.]

(Id10479) [Select any of the following words that were mentioned as present in the narrative.]

Some of the following questions may be repetitive or irrelevant to the respondent but they are very important in the COD assignment process.

Medical history associated with final illness

Explain to the respondent that the following section contains a series of questions on whether diagnosis from a health professional was obtained for a number of illnesses. Clarify that the aim of this series is on medical diagnosis of specific illnesses, and not on signs and symptoms or the perceived cause of death by the respondent.

(Id10125) Was there any diagnosis by a health professional of tuberculosis?

(Id10126) Was an HIV test ever positive?

(Id10127) Was there any diagnosis by a health professional of AIDS?

(Id10128) Did (s)he have a recent positive test by a health professional for malaria?

(Id10129) Did (s)he have a recent negative test by a health professional for malaria?

(Id10482) Was there any diagnosis by a health professional of COVID-19?

(Id10483) Did s(h)e have a recent test for COVID-19?

(Id10484) What was the result?

(Id10130) Was there any diagnosis by a health professional of dengue fever?

(Id10131) Was there any diagnosis by a health professional of measles?

(Id10132) Was there any diagnosis by a health professional of high blood pressure?

(Id10133) Was there any diagnosis by a health professional of heart disease?

(Id10134) Was there any diagnosis by a health professional of diabetes?

(Id10135) Was there any diagnosis by a health professional of asthma?

(Id10136) Was there any diagnosis by a health professional of epilepsy?

(Id10137) Was there any diagnosis by a health professional of cancer?

(Id10138) Was there any diagnosis by a health professional of Chronic Obstructive Pulmonary Disease (COPD)?

(Id10139) Was there any diagnosis by a health professional of dementia?

(Id10140) Was there any diagnosis by a health professional of depression?

(Id10141) Was there any diagnosis by a health professional of stroke?

(Id10142) Was there any diagnosis by a health professional of sickle cell disease?

(Id10143) Was there any diagnosis by a health professional of kidney disease?

(Id10144) Was there any diagnosis by a health professional of liver disease?

History of injuries/accidents

(Id10077) Did (s)he suffer from any injury or accident that led to her/his death?

Injuries and accidents detail

(Id10077_a) How long after the injury or accident did s/he die?

(Id10077_b) [Interviewer click "OK" to confirm the answer: She/died less than or equal to 7 days after the accident]

(Id10079) Was it a road transport injury?

(Id10082) Was it a non-road transport injury?

(Id10083) Was (s)he injured in a fall?

(Id10084) Was there any poisoning?

(Id10085) Did (s)he die of drowning?

(Id10098) Was the injury accidental?

(Id10099) Was the injury self-inflicted?

(Id10100) Was the injury intentionally inflicted by someone else?

Risk factors

(Id10411) Did (s)he drink alcohol?

Civil registration numbers

Civil registration: "This refers to the legal death certificate obtained from the civil registration authorities (show image of local death certificate if available)."

(Id10069_a) Do you have a Death Certificate from the Civil Registry?

(Id10070) [Death registration number/certificate]

(Id10071_check) [Is the date of registration available?]

(Id10071) [Date of registration]

(Id10072) [Place of registration]

(Id10073) [National identification number of deceased]

Medical certificate of cause of death

Death certificate with cause of death: "This refers to the medical certificate of cause of death (show image of local medical certificate of cause of death if available)."

(Id10462) Was a medical certificate of cause of death issued?

(Id10463) Can I see the medical certificate of cause of death?

(Id10464) [Record the immediate cause of death from the certificate (line 1a)]

(Id10465) [Duration of the immediate cause of death (Ia):]

(Id10466) [Record the first antecedent cause of death from the certificate (line 1b)]

(Id10467) [Duration of the first antecedent cause of death (Ib):]

(Id10468) [Record the second antecedent cause of death from the certificate (line 1c)]

(Id10469) [Duration of second antecedent cause of death (Ic):]

(Id10470) [Record the third antecedent cause of death from the certificate (line 1d)]

(Id10471) [Duration of third antecedent cause of death (Id):]

(Id10472) [Record the contributing cause(s) of death from the certificate (part 2)]

(Id10473) [Duration of the contributing cause(s) of death (part2):]

Appendix 3: ICD 9 & ICD 10 Codes on Drowning

ICD 9 - 1978 (WHO, 1979)	**ICD 10 - 1994** (WHO, 2016)
External causes of injury	T75.1 Drowning and nonfatal submersion
E521 Accidental drowning and submersion	V90–V94 Water transport accidents
E910 Accidental drowning and submersion	W65–W74 Accidental drowning and submersion
559 Anoxia due to drowning	X34.1 Victim of tsunami
E830–E838 Water transport accidents	X38 Victim of flood
E9104 Drowning in bathtub	X71 Intentional self-harm by drowning and submersion
E9108 Accidental drowning NEC	X92 Assault by drowning and submersion
E9109 Accidental drowning NOS	Y21 Drowning and submersion, undetermined intent
9941 Drowning/nonfatal submersion	
E9954 War injury: unintentional drown	Y36.4 Drowned in war operations NOS