

Supplementary file 1: Summary of articles

Reference, study design, location of study, N (sample)	Target pop, age	Short description	Results/Outcome
Arcury, 2002 ²⁸ Qualitative study - interviews North Carolina, USA N = 197	Adults, Ethnic-minority pop farmworkers	Water safety knowledge and behaviours among agricultural workers in North Carolina, of which a high proportion are of Latino background.	91% male, 34% did not know how to swim. Alcohol and limited/no swimming ability major risk factors for drowning among this population.
Berukoff & Hill, 2010 ⁵⁰ Quantitative - surveys and physical testing Los Angeles, USA N = 144	high school students (13 – 18yrs) Ethnic-minority pop	Study of Hispanic/Latino students living in a low SES area. To determine the relationship of swimming performance against six factors: swimming self-efficacy, fear of drowning, perceived risk, previous opportunities, body image, and perceived skill.	Males scored higher on the swimming performance test, and reported a lower fear of drowning and perceived swimming risks than females. Self-efficacy was a strong predictor of swimming performance. Fear was found to be a major factor that influenced basic swimming ability.
Croft & Button, 2015 ⁶² Epidemiological - coronial data New Zealand N = 2134	Adults (15 – 80+ yrs) Male	Analysis of adult male drowning in New Zealand.	Different ethnicities drown while engaged in different activities. NZ Europeans were more likely to drown from an accidental immersion or when using powered boats. In contrast, a high incidence of drowning deaths when fishing, diving/snorkelling were strongly linked to ethnic-minority groups.
Felton et al, 2015 ⁸ Epidemiological - hospitalisation data USA N = 19,403	Children (0 – 21 yrs) Ethnic-minority pop	Analysis of trends and risk factors associated with non-fatal drowning of infants and children in the USA (including ethnicity) between 2006-2011.	The highest rates of non-fatal drowning occurred in swimming pools and in children from ethnic minorities. Non-white children are roughly four times more likely to have a non-fatal drowning across all age groups compared to white children. Overall, Hispanic children reported the highest proportion of non-fatal drowning.
Fife & Golddoft, 1994 ⁴⁹ Qualitative - telephone interviews New Jersey, USA N = 6366	Parents of children <14 years, Ethnic-minority pop	Differences in children's swimming competency by age and ethnicity/race.	Non-white children have a lower swimming competence compared to white children when analysed by age and sex (p<0.001), except aged 0 - 4 years.
Gallinger, Fralick & Hwang, 2015 ³⁷ Epidemiological – Coronial and census data Ontario, Canada N = 492	All ages Ethnic-minority pop Male Rural residents	Drowning rates analysed by ethnicity and location of residency (urban/rural) using age-standardized rates by sex and place of residence (rural vs. non-rural) for people of each ethnicity group using the method of direct standardization.	People of Asian, Greater African, or Hispanic ethnicity living in rural Ontario were reported to have significantly higher drowning rates than those of Great European ethnicity, especially those living in rural areas, and were less likely to have alcohol present. Men living in rural areas of Ontario, regardless of ethnicity, had reported a drowning rate 2–25 times higher than men living in non-rural areas
Gilchrist & Parker, 2014 ⁹ Epidemiological – CDC data USA N = not presented	0 – 30 yrs Ethnic-minority pop	An analysis of national drowning data of children and young adults aged between 0 -29 years over a 12 year period by ethnicity/race.	Disparities between race/ethnicity were evident. American Indians/Alaska Natives were twice, and black children were 1.4 times more likely to drown than White children. The drowning rates for black children were significantly higher than those for whites and Hispanics at every age from 5 years through 18 years. Drowning in a swimming pool was almost six times more likely among black children aged 5–19 years compared to white children.
Giles, Castleden & Baker, 2010 ²⁵ Qualitative – interviews North Western Territories of Canada N = 21	Adults Aboriginal	Investigation of effective drowning prevention communication strategies for Native Canadians. This study highlighted the importance of incorporating cultural knowledge when planning drowning prevention/water safety campaigns.	Two main topics emerged: 1) respect and knowledge (especially of elders) and 2) place-based risk experience/communication. Participants reported that community Elders' knowledge has been displaced by technical, certification-based instructors with little practical experience or knowledge the local environment
Giles & Rich, 2013 ²⁴ Qualitative - interviews and focus groups North West Territories, Canada N = 7	Teenagers and adults (16 - 25 yrs) Indigenous	Evaluation of a modified pool lifeguard program tailoring to cultural needs and specific environmental differences compared to rest of the country.	Main themes of the focus groups: contextual appropriateness; course format was too long, with not enough opportunity to practice skills; importance of community members employed in local facilities to increase local participation; Aboriginal traditions, beliefs and specific information on local waterways need to be included.
Gorsuch et al, 2018 ³² Epidemiological- state level drowning data Florida, USA N = not presented	All ages Ethnic-minority pop	Reductions of drowning rates among Florida's black populations since the 19070s.	Since 1970, the drowning rate for black males declined from over 15 deaths per 100 000 to under four deaths per 100 000. From 2005, no difference were evident between the overall white and black male drowning rate.
Hastings, Zahran, & Cable, 2006 ⁵³ Epidemiology - multiple data sources USA N = N/A	All ages Ethnic-minority pop	Analysis of swimming participation and drowning data in American to establish a link between drowning rates base on ethnicity/race.	Uses primary data from multiple sources (national level databases) to draw conclusions that age, sex and ethnicity/race are influencing factors in participation in swimming activity, with blacks and native America least likely to be participating in formal swimming clubs, suggesting a link to between participation and increased risk of drowning rates among ethnic-minority populations.
Hudson et al, 2007 ²² Epidemiological - hospital data Alaska, USA N = 176	All ages All Ethnic pop	Analysis of risk factors contributing to non-fatal immersion accidents and associated additional injuries associated with the incident.	Ethnicity was also strongly associated with Associated Injury outcomes, with white Alaskans significantly more likely to experience injuries than other groups. Native Alaskans made up a higher proportion of immersion-only cases (43%) compared to no submersion cases (20%).

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Irwin et al, 2011 ⁴³ Quantitative – cross-sectional survey Six cities in USA N = 1680	Children (11-16yrs) Parents (child 4-11 yrs) Ethnic-minority Low SES pop	Explorative study investigating fear of water and drowning among children and their parents, and how this impacts participation in swimming activity.	Parents of minority populations were more likely to report fear of their child drowning/injury in the water compared to other parents and African-American females were most likely to report fear of water/drowning, and white youth reported being least fearful of drowning/injury while swimming.
Irwin et al, 2009a ⁴⁸ Quantitative - cross-sectional survey Six cities in USA N = 1680	Children (11- 16 yrs) Parents of children (4-11 yrs) Ethnic-minority pop Low SES pop	Examination of swimming participation and ability among ethnic-minority youth from a parent and youth perspective.	Overall, 51.2% were considered "at-risk" swimmers. Children from ethnic-minority populations reported the highest levels of "at-risk" swimming ability.
Irwin, Irwin, Ryan, & Drayer, 2009b ⁴⁴ Quantitative – cross-sectional survey Six cities in USA N = 1680	Children (11- 16 yrs) Parents of children (4-11 yrs) Ethnic-minority pop Low SES pop	To determine if reported barriers to swimming participation for minority children were myths or truth.	Findings reported that minority children want to learn to swim. Parental factors that influence participation included; parent/caregiver swimming ability, fear of drowning, encouragement of child learning to swim. Myths around personal appearance was not reported as an issue among survey respondents.
Ito, 2014 ⁴⁵ Qualitative research methods Chicago, USA N = 19	Adults African-American	A study utilising a qualitative research design to examine the current curriculum and context of water safety and swimming education in the United States for African-American populations.	Barriers to learning swimming for African-American populations include: lack of access to facilities and lessons, poor swimming ability, cultural capital, customs, attitudes and values that are passed down through generations, embedded values, including a fear of water. Racial segregation of public swimming facilities may be a historical factor influencing current African-American participation.
Jasper, Stewart & Knight, 2017 ⁴⁰ Quantitative – surveys Western Australia N = 236	Adults Asian ethnicity Rock Fishers	Survey results of rock fishers at a popular fishing location in Western Australia	53% of respondents were born in Asia. 92% agreed that drowning was a threat their life if swept off the rocks, 78% reported never wearing a lifejacket when fishing, 58% believed that their swimming ability would assist in getting them out of trouble. 41% of participants were visiting the location for the first time, 21% reported poor swimming ability. A higher proportion of people with limited English language fished from rocks compared to those who always spoke English.
Lee, Mao, Thompson, 2006 ²⁹ Epidemiological - hospital data Massachusetts, USA N = 267	Children (0-19 yrs) Male Ethnic-minority pop	Analysis of outcomes of a fatal or non-fatal drowning incident among children admitted to hospital by ethnicity/race and age	Gender, age and ethnicity appeared to be factors contributing to outcomes after a drowning episode. African-American children reported worse outcomes compared to White children, whereas Hispanic children reported better outcomes than white children. Males were 2.52 (95% confidence interval = 1.31 to 4.84) times more likely to have worse outcomes than females.
Mael, 1995 ⁴⁶ Quantitative - surveys, biometric data and practical swimming test USA N = 2549	Adults (military cadets) non-white adults	Differences in swimming ability between African-American and White military recruits when testing swimming skills and correlating against a biodata questionnaire to determine differences between ethnicity/race.	Age when taught swimming was the best predictor of swimming ability. Over 90% of White recruits had learned to swim by age 9 compared with 58% of Black recruits. Blacks were also less proficient swimmers than were Whites who learned to swim at the same age. Among both Blacks and Whites, cadets who were more studious and better academic performers were poorer swimmers. Birth order was a significant swimming correlate for Blacks.
Mitchell & Haddrill, 2004 ⁴¹ Qualitative – focus groups and interviews Sydney, Australia N = 95	Adults and teenagers Migrants of Asian ethnicity	Developing water safety strategies informed by the Chinese community (as a high-risk population for drowning in Australia).	All participants had previously participated in aquatic activity, the most popular activities were swimming, boating/fishing and rock fishing. Around two-thirds of Chinese-speaking tourists had participated in aquatic activities whilst in Sydney and at least one-third had been swimming, or surfing at a beach. One-third were aware of swimming between the red and yellow flags at the beach as a safety measure.
Moran, 2017 ³⁹ quantitative - cross-sectional survey Auckland, New Zealand N = 413	Adults Rock fishers Migrants	Results of a 10 year study of drowning risk, water safety knowledge and behaviour of rock fishers. Surveys were conducted at rock fishing sites in the same geographical location annually during the southern hemisphere summer months (Dec – Feb). Based on Protection Motivation Theory.	91% were male, 52% were of Asian background, and 73% had lived in NZ for 10 years or more. Key behaviour change reported in lifejacket wear – 4% 'often/always' wore at the start of the study period to 40% at the end of the study period. Most fishers' perception of the severity of the drowning risk and perceptions of their vulnerability to that risk increased over time.
Moran, 2008 ⁵¹ Quantitative – cross-sectional survey New Zealand N = 2202	high school students (Year/grade 9, 15-16 yrs.)	Findings of a national youth water safety survey, conducted with high school students. Significant differences were found when analysed by gender, ethnicity and socio-economic status.	54% reported that they could not swim more than 100m, and 43% could not perform CPR. More students from schools in low socio-economic locations were unable to swim 50m compared to students attending schools in higher socio-economic locations. Students of Asian backgrounds reported the lowest levels of water safety knowledge; 41% were unable to identify any surf hazards, make any safety decisions (50%), or identify the safest location on the beach (50%).
Moran & Willcox, 2013 ²⁶ Quantitative – cross-sectional survey Auckland, New Zealand N = 570	Adults Migrants of Asian ethnicity	Water safety knowledge, attitudes and aquatic participation of Asian new migrants in New Zealand	78% reported that they now participated in more aquatic activity in NZ compared living in their homeland, mostly swimming in public pools. Half (50%) had never swum at a beach, 54% had collected shellfish and 40% had been land-based fishing. 63% had not received any water safety knowledge previously, 32% thought that they were unable to float, 64% thought that they could not perform CPR.

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Myers, Cuesta & Lai, 2017 ³⁰ Epidemiological - CDC drowning statistics and USA swimming membership data USA N = not presented	Children (7-18yrs) African-American	Investigates the relationship between competitive swimming participation and drowning rates by ethnicity/race on a national level.	A strong inverse relationship was found between competitive swimming rates among African-Americans and unintentional drowning deaths. Findings reported that a 1% age point increase in competitive swimming reduces unintentional drowning rates by 20.12 per 100,000. Increasing competitive swimming among African-American males by one percentage point could reduce the unintentional drowning events by 23.47 per 100,000, and for African-American females, the same increase may reduce the drowning events by 8.04 per 100,000. In contrast, competitive swimming does not have statistically significant effects on unintentional drowning among white males and females.
Olaisen, Flocke & Love, 2017 ⁴⁷ Quantitative – Intervention evaluation California, USA N = 149	Children (3 - 14 years) Ethnic-minority pop	Evaluating the effectiveness of a swimming program for Latino children aged 3 - 14 years	An 8-week swim intervention was found to be effective at increasing children's swimming skills. Children that participated in 10 lessons or more developed more skills than children who attended less number of lessons.
Quan et al, 2006 ³⁶ Qualitative - focus groups Washington, USA N = 35	Teenagers (15–19 yrs) and parents Vietnamese-American	Exploring cultural beliefs around drowning and water safety among the Vietnamese community	Cultural beliefs in regards to drowning and water safety knowledge were cited as reasons for a lack of participation in swimming activity, lifejackets were only used for non-swimmers, low awareness of drowning risk were reported among parents. Vietnamese do not think about water in a recreational sense and do not learn how to swim. Parents reported fatalistic beliefs about drowning and had spiritual beliefs about avoiding water due to ghost in certain water bodies, teenagers did not believe this.
Ross et al, 2014 ³³ Qualitative - focus groups Six cities, USA N = 72	Parents of young children Ethnic-minority pop Low SES	Investigating key barriers to swimming participation for African-American children from a parent's perspective.	Focus groups participants cited reasons for low participation in swimming activity include: economic, cultural, access/lack of transport, swimming lessons not included in facility membership fees, lack of parental support for acquiring swimming skills due to fear of water or drowning.
Rousell, & Giles, 2011 ³⁵ Qualitative (case study) - interviews and focus groups North West Territories, Canada N = 17	Teenagers and adults (12 – 65 yrs) Indigenous / Aboriginal	Study about how lifeguard leadership at a public pool can influence participation of Aboriginal youth and how lifeguard attitudes can result in a negative experience and the impact on staff recruitment within the community.	The findings reported that Aboriginal youth and their parents found the pool an undesirable place to spend leisure time and to engage in future employment due to the excessive surveillance they encountered. The findings highlighted the need for incorporating cultural competency into lifeguard leadership training in order to make the local community feel more welcome and increase participation.
Saluja et al, 2006 ³¹ Epidemiological - drowning death data USA N = 678	Children and adults (5 - 24 yrs) Ethnic-minority pop	A national study of swimming pool drownings among children and young adults aged 5-24 years analysed by ethnicity/race.	African-American males presented the highest risk of drowning. Foreign born males aged 5-9 years had a higher risk for drowning (1.6/100000) compared with American-born males of the same age. Type of pool varied with age and ethnicity/race. Black victims accounted for 71% of drowning deaths in hotel/motel pools. Hispanic drowning deaths mostly occurred in neighbourhood pools. 50% of children aged 5 - 9 years drowned in residential pools, 50% of children 10-14 years drowned in public pools.
Savage, & Franklin, 2015 ⁵² Retrospective, mixed-method study Sydney, Australia N = 63 (survey participants)	Adults Ethnic-minority pop	Study included an evaluation of a modified swimming instructor course specifically tailored to engage and increase participation among participants from culturally diverse backgrounds.	Three different delivery models were trialed for culturally diverse participants, with a 94% completion rate. Successful modifications included: mentoring component, removal of exam at the end of the course, use of visual aids. Key finding was that language is not the key barrier as usually believed. Success attributed to a combined learning approach, paired with meaningful practical applications and providing ongoing mentor support.
Siano et al, 2010 ³⁴ Quantitative - surveys Florida, USA N = 1624	Parents Ethnic-minority pop	A survey of parents with children admitted to a paediatric emergency department on their child's swimming experience and ability.	64% of parents believed that their child could swim proficiently by 4 years old, differences were evident when analysed by ethnicity. Significantly more Hispanic parents reported that their child could not swim compared to White and African-American parents (P<0.01). Hispanic and African-American children were less likely than White children to swim by the age of 4 years regardless of having attended lessons.
Stanley & Moran, 2018 ³⁸ Quantitative – cross sectional survey Auckland, New Zealand N = 194	Adults Ethnic-minority pop	Water competency among adults of minority population groups (identified as high-risk for drowning).	91% believed they could swim, 70% considered their competence to be good/very good, 72% estimated they could swim 25m or less. Most participants reported risky water safety attitudes, with significant gender differences were evident. Males from disadvantaged low SES minority groups may be at greater risk of drowning.
Wallis et al, 2015 ¹⁵ Epidemiological - hospital data Queensland, Australia N = 87	Children 0 -19 years, Indigenous / Aboriginal Rural residents	An epidemiological study of fatal and non-fatal drowning among Indigenous children in Australia.	Indigenous children were found to be at greater risk of drowning than other children in Australia. Crude rates calculated reveal a drowning rate of 16.8/100,000 per annum for Indigenous children 0-19 years, 1.44 times higher than the incidence rate for Non-Indigenous children, rates are higher for females than males. A higher incidence of Indigenous drowning deaths occurred in regional and remote geographical locations, compared to 98% of non-Indigenous cases occurring in major cities.
Willcox-Pidgeon, Kool, & Moran, 2018 ³⁷ Quantitative –cross-sectional survey Auckland, New Zealand N = 599	high school students (16 -18 yrs) Ethnic-minority pop	Study of surf safety knowledge, swimming competency, confidence and behaviour of youth (16 - 18 years) when at a surf beach. Significant differences were found when analysed by gender and ethnicity.	Differences were evident between different ethnic groups and self-reported swimming competency, confidence in swimming in the surf, behaviour and rip current knowledge. Asian students reported a poorer swimming ability than New Zealand European and Maori students; New Zealand European students were more likely to report being confident swimming at a surf beach and participating in risk taking behaviour

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			such as swimming at an unpatrolled beach, swimming on their own, and outside of the patrol flags, compared to students of other ethnicity groups.
Willcox-Pidgeon, Kool, & Moran, 2018 ⁴² Quantitative – cross-sectional survey Auckland, New Zealand N = 599	high school students (16 -18 yrs) Ethnic-minority pop	Understanding youth risk perception of drowning at surf beaches. Differences found when analysed by gender and ethnicity. Uses the Protection Motivation Theory.	Differences in risk perception of drowning were found when analysed by gender and ethnicity. Overall 70% ranked being caught in a rip current the greatest risk of drowning. Females and non-NZ European students reported higher levels of perceived vulnerability and severity of drowning risk, NZ European reported higher levels of self-efficacy of preventative actions.