Protocol: Prevalence of dehydration among older adults across settings: a systematic review and meta-analysis

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Potential conflicts of interest

None known.

Background

Increased dehydration risk for older adults

Dehydration is defined as "the loss of body water, with or without salt, at a rate greater than the body can replace it" (Thomas et al., 2008, p. 292). The European Society for Clinical Nutrition and Metabolism recommends the term *low-intake dehydration*, to define dehydration caused by insufficient fluid intake (Volkert et al., 2019), to provide some clarity amongst the various definitions within the literature. Low-intake dehydration is frequently reported amongst older adults (D. K. Bunn & Hooper, 2019; Lee Hooper et al., 2016; L. Hooper et al., 2016). Dehydration in the older adult population is a complex picture. As people age, physiological changes occur which disturb the body's usual homeostasis, leaving them more susceptible to dehydration; the total amount of water the body stores reduces as one ages (Weitzman & Kleeman, 1979) and their thirst sensation is less effective (Davies, O'Neill, McLean, Catania, & Bennett, 1995), which results in lower fluid intake. Moreover, the kidneys are less effective at concentrating urine as one ages (Davies et al., 1995), which leads to increased fluid loss. Older adults may be more physically inhibited to access fluid provision due to increased frailty or reduced mobility restricting their ability to make, open or reach for drinks (J. McCrow, M. Morton, C. Travers, K. Harvey, & E. Eeles, 2016; Judy McCrow, Margaret Morton, Catherine Travers, Keren Harvey, & Eamonn Eeles, 2016). This issue can be perpetuated at shopping level, whereby it might be difficult for an older adult to carry shopping, comprising heavy containers of drinks/fluids. Moreover, Older adults might consciously reduce their fluid intake due to anxiety regarding urinary incontinence (Bhanu et al., 2019; Wham, Smithers, Kruger, Mazahery, & Richter, 2020). Communication difficulties can also inhibit fluid intake for older adults, as a result of neurological difficulties or not having the opportunity to, or not feeling comfortable enough to request fluids (Schols, De Groot, van der Cammen, & Olde Rikkert, 2009). Finally, cognitive impairment and dementia in older adults is associated with lower fluid intake (Armstrong-Esther, Browne, Armstrong-Esther, & Sander, 1996; Nagae et al., 2020; Wu, Wang, Yeh, Wang, & Yang, 2011) due to these individuals not being able to recognise drinks, or forgetting to access fluids to maintain adequate levels of hydration (J. Mentes, 2006). Dehydration has significant health impacts for older adults, and substantial economic impacts for society (Xiao, Barber, & Campbell, 2004). There are multiple factors which could affect the risk of dehydration for older adults and some of these factors will be discussed in the following sections.

Economic and health impact of dehydration

Dehydration in older adults is associated with significant comorbidity and mortality (L. Hooper et al., 2016; Warren et al., 1994; Wilson et al., 2019; Xiao et al., 2004). Adverse health events such as urinary tract infections, acute infections, falls and pneumonia have all been associated with dehydration in older adults (Warren et al., 1994; Wilson et al., 2019). Comorbidities which are common in older age, such as frailty, cancer (Warren et al., 1994), diabetes, renal impairment and cognitive impairments are also associated with dehydration in this population(L. Hooper et al., 2016), although the direction of causation is unclear. A scoping review identified numerous pathological risk factors associated with dehydration in older adults, which included having more than four chronic diseases, cardiovascular disease, presence of infection and diabetes (Masot et al., 2018) . Hospitalised older adults have been found to be twice as likely to die in hospital, if they have been diagnosed with dehydration, compared to those without dehydration (19.8% vs 7.1% respectively, $p<0.001$) (A. M. El-Sharkawy et al., 2017). Dehydration is associated with increased risk

of falls, delirium, hospitalisation, death, infections and a number of other conditions in older adults, though robust causal evidence is lacking (N. Campbell, 2012; Thomas et al., 2008; Wilson et al., 2019).

Specifically, the UK DRIE study found that diabetic status, poorer cognitive status and poorer renal function were consistently (using different statistical models) associated with significantly higher serum osmolality (L. Hooper et al., 2016). The UK DRIE study involved 188 participants across 56 English care homes, with a mean age of 86 years (L. Hooper et al., 2016). The study aimed to establish the prevalence of dehydration, as measured by serum osmolality, and investigate the characteristics associated with low-intake dehydration (L. Hooper et al., 2016). Impending dehydration was classified as 295-300mOsm/kg and current dehydration was classified as >300mOsm/kg (L. Hooper et al., 2016). Within the UK DRIE study sample, it was found that diabetic older adults had nearly quadrupled odds of impending dehydration within their sample of older adults living in long term care (OR = 3.77, p=0.003) (L. Hooper et al., 2016). Diabetic older adults from the UK DRIE study were also at higher odds of current dehydration (OR=6.77, p=0.001) (L. Hooper et al., 2016). Another study has since also found that diabetes was significantly associated with elevated serum osmolality in their sample of long term care residents (p<0.001) (Marra et al., 2016). Cognitive impairment has been found to be associated with dehydration among older adults, in community, hospital and long term care settings (A. M. El-Sharkawy et al., 2017; Fogg, Griffiths, Meredith, & Bridges, 2018; L. Hooper et al., 2016; Marra et al., 2016; J. C. Mentes, Devost, & Nandy, 2019). At the time of the UK DRIE study, no other study had found associations between impending and current dehydration and renal function (L. Hooper et al., 2016). The glomerular filtration rate of kidneys is maintained when kidneys are able to conserve water depletion via intrarenal vasoconstriction (Roncal-Jimenez, Lanaspa, Jensen, Sanchez-Lozada, & Johnson, 2015). When the kidneys are unable to effectively conserve water, such as in older age, the glomerular filtration rate falls (Roncal-Jimenez et al., 2015). Chronic kidney disease can be defined as “an estimated glomerular filtration rate of <60ml/min/1.73m²”(Kuwabara et al., 2017; O'Hare, 2009) and is prevalent in older adults. Dehydration has been linked to acute kidney injury (A. M. El-Sharkawy et al., 2017) and chronic kidney disease (Kuwabara et al., 2017; Roncal-Jimenez et al., 2015). In a five-year Japanese cohort study, serum osmolarity (calculated via the Bhagat equation (Bhagat, Garcia-Webb, Fletcher, & Beilby, 1984)) (OR: 1.04, 95% CI 1.03-1.05), serum sodium (OR: 1.03, 95% CI 1.00-1.07) and BUN (OR:1.08, 95% CI 1.06-1.10) were all found to be significant predictors of chronic kidney disease (Kuwabara et al., 2017), demonstrating a relationship between dehydration and renal function. A hospital-based study found statistically significant differences in acute kidney injury diagnoses between dehydrated and euhydrated older adults admitted to hospital (p<0.001) (A. M. El-Sharkawy et al., 2017). Due to the significant association found by the UK DRIE study (L. Hooper et al., 2016), this systematic review aims to investigate any differences in dehydration prevalence among older adults diagnosed with renal impairment, cognitive impairment and/or diabetes.

The economic burden of dehydration is calculated using hospitalisation costs, including equipment and personnel costs, social care costs for discharge of patients and income lost by patients and family caregivers (Frangeskou, Lopez-Valcarcel, & Serra-Majem, 2015). Dehydration is commonly reported as a comorbidity of other primary diagnoses being treated in hospital, and thus this also incurs additional costs (Frangeskou et al., 2015). No recent studies or reports have provided robust estimates of the economic burden of dehydration alone, due to the difficulty of using administrative diagnosis codes to categorise dehydration (Frangeskou et al., 2015), which do not reflect accurate costs implicated in each hospitalisation. Moreover, discharge and readmission data are not always correctly reported and thus economic burden cannot be accurately calculated (Frangeskou et al., 2015). In the US, dehydration was a top 10 reason for Medicare hospital admissions in 1991 and cost

over $446 million to treat (Warren et al., 1994). The economic burden of dehydration in the US is substantial and was estimated to be as high as $1.4 billion in 1999, demonstrating a continued need to address preventable hospitalisations for dehydration (Xiao et al., 2004). In order to precisely calculate the economic burden of dehydration for older adults, accurate and robust data are required to establish the true prevalence of low-intake dehydration amongst older adults.

Dehydration in different care settings and dependency on others

Care settings and dependency are interlinked factors for investigating dehydration prevalence amongst older adults. Older adults move into long term care settings due to requiring more support and assistance carrying out activities of daily living and personal care (Age UK, 2020). Additionally, there are precipitating factors which make individuals more dependent on others to facilitate their care provision, such as having cognitive impairment, psychiatric problems, or reduced functional status; these individuals are more likely to reside in long term care settings or be admitted to hospital (Knapp et al., 2016). However, dehydration has been reported amongst older adults residing in long term care settings, hospitals and community settings (A. M. El-Sharkawy et al., 2017; Gaspar, 1988; L. Hooper et al., 2016; Kayser-Jones, Schell, Porter, Barbaccia, & Shaw, 1999; J. C. Mentes et al., 2019; Jodi Dunmeyer Stookey, 2005; Wu et al., 2011). This section will look at the prevalence of dehydration in different care settings (long term care, hospitals, and community) and how dependency on others confounds this association.

Nursing homes vary worldwide as to which model of care they use; some nursing homes are nurse-led, some are physician-led and some are led by health and social care professionals, where registered nurses and physicians visit when required (Tolson et al., 2013). Some countries still use geriatric hospitals to provide subacute care to older adults, whereas long term care is the only option offered in 77% of countries (Tolson et al., 2013). The wide variation in how nursing homes and care homes operate, makes it more difficult to pinpoint universal risk factors to dehydration in these settings. A 1996 UK study comparing long term care wards, psychogeriatric wards and geriatric admission wards, found that there was a significant inverse relationship between dependency and fluid intake ($p<0.04$) (Armstrong-Esther et al., 1996). This study suggests that dependency on others is a key factor for dehydration prevalence, irrespective of which ward the older adults resided on (Armstrong-Esther et al., 1996). Perhaps relatedly, in an anthropological study of a US nursing home, it was found that the predominant factor contributing to reduced fluid intake, was residents not being able to reach for their drinks, or not being assisted with their drinks (Kayser-Jones et al., 1999). Residents of nursing homes are reliant on care staff to assist with their hydration care provision and thus this once again shows that dependency on others is a key underlying issue for dehydration (Kayser-Jones et al., 1999). A study has previously compared fluid intakes of institutionalised and non-institutionalised older adults, over a three day period, and found that the non-institutionalised adults had a significantly higher mean daily fluid intake (1507ml vs 2115ml, respectively, $p<0.005$) (Adams, 1988). This study excluded participants with cognitive impairment (Adams, 1988), which we know is associated with low-intake dehydration, and thus the mean fluid intake might have been lower for both groups, if this population had been included (L. Hooper et al., 2016).

Older adults have also been reported to be dehydrated in hospital settings (A. M. El-Sharkawy et al., 2017). A retrospective cohort study found that dehydration was present in 8.9% of a sample of hospitalised older adults diagnosed with dehydration, over a 2.5 year period (A. M. El-Sharkawy et al., 2017). In the same study, the older adults admitted with a primary or secondary diagnosis of dehydration, were twice as likely to die in hospital ($p<0.001$), compared to the non-dehydrated hospitalised older adults from the same sample, irrespective of comorbidity, gender or age (A. M. El-

Sharkawy et al., 2017). Among older adults being admitted to the Emergency Department of a hospital in Slovenia, it was concluded that patients admitted from institutionalised care were significantly more dehydrated, as measured by serum osmolality ($p=0.009$) and BUN:Cr ratio ($p<0.001$), compared to those admitted from home (Lešnik, Piko, Železnik, & Bevc, 2017). The authors found that the prevalence of dehydration varied depending on which dehydration criteria were applied, using either serum sodium, serum osmolality, BUN:Cr ratio or BUN, and also which cut offs were used (Lešnik et al., 2017). One study found that adults aged 65 years old and over, and living with dementia, are at a higher risk of hospital admission in general ($p<0.001$), and are also at a higher risk of poorer outcomes after admission ($p<0.001$), when compared to people of the same age, without dementia (Natalwala, Potluri, Uppal, & Heun, 2008). Community-dwelling people living with dementia, were more likely to be hospitalised, due to being more likely to have physical health problems, be dehydrated, have infections, or be experiencing a psychiatric crisis, on admission to hospital, when compared to those living without dementia (Toot, Devine, Akporobaro, & Orrell, 2013). People living with dementia are more reliant on others for assistance with activities of daily living, and thus is it not surprising that they might be admitted to hospital dehydrated, as they might lack support with hydration care provision in the community (J. Mentes, 2006). It has been found that fluid intake was significantly lower in hospitalised older adults in New Zealand, who had difficulty opening hospital fluid lids compared to those with no difficulty opening the lids (mean: 1.6l vs 2.0l, respectively, $p=0.005$), though serum osmolality levels were not statistically different for these groups ($p=0.17$) (Wham et al., 2020). This demonstrates how dependent hospitalised older adults may be on hospital staff to meet their hydration care needs.

Community-dwelling older adults are also at risk of being dehydrated (J. C. Mentes et al., 2019; Jodi Dunmeyer Stookey, 2005). Older adults living with dementia, living at home, are more likely to become dehydrated due to forgetting to drink, not knowing how much to drink, or when to drink, which increases their likelihood of being hospitalised or being admitted to a care home for more support with activities of daily living (Thoma-Lürken, Bleijlevens, Lexis, De Witte, & Hamers, 2018). Mentes et al., (2019) found that their sample of community-dwelling participants were “chronically under-hydrated” (p.6), when measuring salivary osmolality to assess dehydration. Mentes et al. (2019) found that in their sample, dehydration was resultant of psychological barriers of the older adults restricting fluids due to urinary incontinence or forgetting to drink, rather than as a consequence of physical barriers to drinking, such as functional status. However, data from the 1992 American Established Population for the Epidemiological Study of the Elderly (EPESE), found that elevated plasma tonicity (indicating dehydration) was higher in community-living older adults living with chronic disease co-morbidity ($p<0.05$), diabetes ($p<0.05$) and functional impairment ($p<0.05$) (J. D. Stookey, Pieper, & Cohen, 2005), suggesting that functional status is associated with dehydration risk. Dehydration needs to be detected early, in order to prevent the older adult from becoming more vulnerable from further comorbidities (L. Hooper et al., 2016; Warren et al., 1994; Wilson et al., 2019), as a result of becoming dehydrated, consequently preventing admission to hospital or long term care settings (Knapp et al., 2016; Natalwala et al., 2008; Thoma-Lürken et al., 2018). It is crucial that we understand in which settings low-intake dehydration is more prevalent, so that interventions and strategies can be implemented to prevent dehydration. It is also important to understand better what factors are contributing to dehydration, and how these might vary between settings.

Global differences in hydration care provision

Studies investigating the prevalence of dehydration amongst older adults are predominately conducted in Western countries with developed economies, which might have different health and

social care infrastructure, compared to countries with less developed economies. Developing countries might have different public health agendas, compared to those with developed economies, such that low-intake dehydration is not a primary health concern. Moreover, public health research might be funded differently, and give priority to different conditions, in less developed countries. A handful of studies have investigated the prevalence of dehydration in less economically developed countries and have also reported high prevalence of dehydration in their care settings, though this has not always been measured using serum osmolality (Leibovitz et al., 2007; Shin & Hyun, 2015; Wu et al., 2011). There also might be cultural differences in settings around the world for hydration care provision, which need to be explored, by means of what types of fluids are consumed, availability of fluids and staff training, which have all been identified as having a possible positive effect on fluid intake (D. Bunn, Jimoh, Wilsher, & Hooper, 2015). A systematic review is needed to collate the data on global differences in dehydration prevalence for older adults.

Effect of staffing on hydration prevalence

There is some evidence to suggest that higher staffing ratios are related to improvements in some aspects of quality of care provided to older adults living in nursing homes (Backhaus, Verbeek, van Rossum, Capezuti, & Hamers, 2014). One study found that the primary cause of inadequate fluid intake in two nursing homes, was due to care assistants having to rush drinking assistance to residents, as a result of insufficient staffing (Kayser-Jones et al., 1999). An American study found that the prevalence of low food and fluid intake was lower when there was a mean 4.7 care staff per nursing home resident, compared to a mean 8.2 care staff per residential care/ assisted living resident (Reed, Zimmerman, Sloane, Williams, & Boustani, 2005), suggesting that staffing ratios might be relevant for dehydration risk in older adults. However, formal care in the community in the UK, is often carried out 1:1, depending on the level of care needs. Research investigating dehydration in community-dwelling older adults receiving informal care and support, shows that dehydration risk is still prevalent in the community (Bhanu et al., 2019; J. C. Mentes et al., 2019), and thus the effect of staffing ratios on dehydration risk deserves further investigation.

There is also some evidence to suggest that care provided by registered nurses, is associated with better resident outcomes, including lower dehydration prevalence (Anderson, Hsieh, & Su, 1998). The World Health Organisation (WHO) describes a 'nursing professional' as someone whom "requires formal training at a higher institution in nursing" (World Health Organization, no date, p. 3) and in the UK, a registered nurse is a nursing professional who is registered with the Nursing and Midwifery Council, and who is accountable for their practice (as outlined in the NMC Code of Conduct (Nursing and Midwifery Council, 2018)). One study found that the main cause of inadequate fluid intake by older adults, in two American nursing homes, was due to inadequately trained staff and care assistants being inadequately supervised by registered nurses (Kayser-Jones et al., 1999). Another study in nursing homes in Korea, found that the registered nurses' and care assistants' hours per resident per day were not statistically significant on the prevalence of dehydration in nursing home residents (β=-0.08, p.0.33) (Shin & Hyun, 2015). Interestingly, in the same study, there was a significant association between a higher turnover of registered nurses and increased dehydration prevalence (β=0.0012, p=0.05) and a significant association between a higher turnover of care assistants and lower dehydration prevalence (β=-0.001, p=0.03 (Shin & Hyun, 2015). These findings suggest that although the number of nursing hours per resident did not have a significant effect on dehydration prevalence, in this particular study, there is evidence to suggest that registered nurses have a role to play in preventing dehydration for nursing home residents. A meta-analysis found that a higher proportion of registered nurses, amongst care/nursing staff in acute

care hospitals, was directly related to improved patient outcomes (Kane, Shamliyan, Mueller, Duval, & Wilt, 2007). However, dehydration was not included as a patient outcome for this meta-analysis, and thus further investigation into the effect of nursing staffing levels on hydration status is required. Specifically it was found that by increasing one full time registered nurse, per patient, per day, hospital related mortality was reduced (OR 0.96, 95% CI 0.94-0.98) (Kane et al., 2007). One particular case study reported that long-term care staff thought that older adults received improved quality of care, if a nurse or specialist nurse was always on shift, as they were able to guide and coach other staff, and they also reported that health problems were detected sooner (Koopmans, Damen, & Wagner, 2018). In the UK DRIE study, it was found that care homes offering nursing care were associated with lower dehydration levels, when assessed using serum osmolality with a cut off of >300mOsmg, when adjusted for age and sex (adjusted OR: 3.8, 95% CI 1.2, 11.7, p=0.038) (D. Bunn, & Hooper, L., 2016) when compared to residential care homes not offering nursing care. However, these results were underpowered to conclude any statistical significance, so the effect of staff skill mix on dehydration prevalence still requires further investigation.

Effect of Covid-19 public health measures on hydration habits

In 2015, a systematic review reported the possible beneficial impact of environment and social settings on drinking for older adults in long term care (D. Bunn et al., 2015). The importance of the social experience and pleasure of drinking has also been reported by older adults themselves, in community, hospital and care home settings (Bhanu et al., 2019; Godfrey, Cloete, Dymond, & Long, 2012). Moreover, the social setting of a day care centre appeared to facilitate drinking for older adults in attendance (J. C. Mentes et al., 2019). However, in December 2019, the Covid-19 pandemic began in China and spread worldwide throughout 2020. The pandemic had numerous impacts on normal socialisation, with Governments introducing public health measures such as social distancing, shielding for over 70s and the most vulnerable, and no household mixing. Between the periods of April and May 2020, 50.1% of British adults aged 65 years and older, living alone, reported feeling lonely due to lockdown (Office for National Statistics, 2020, p. 5). In the UK, care homes and hospitals were impacted severely with visitors not being allowed into care homes, staff shortages due to illness and significant pressure on the NHS, due to Covid-19 admissions. Although most research into the impact of Covid-19 on older adults is still ongoing, a pre-print paper from University College London reported that 93% of family caregivers were unable to provide the same level of care during the first national lockdown, compared to normal, and 74% of people living with dementia reported a decreased ability to socialise with others during the same period (Suárez-González et al., 2020). The lockdown and public health measures will undoubtedly have had an impact on older adults' hydration habits, due to limited opportunities for drinking in social settings and reduced support with drinking from caregivers. However, research suggests that people drank alcohol on more days during the first British Covid-19 lockdown, when compared to before the lockdown (Naughton et al., 2021). The authors reported that older age was associated with an increase in unhealthy drinking during the first lockdown (Naughton et al., 2021). A recent systematic review reported that improving hydration reduces the risk of pneumonia related mortality, in the medium term (L. Hooper, Abdelhamid, A., Ajabnoor, S., Bassey, C., Brainard, J., Brown, T. J., Bunn, D., Foster, E., Hammer, C. C., Hanson, S., Jimoh, F, O., Maimouni, H., Sandhu, M., Winstanley, L., Cross, J. L., Welch, A. A., Rees, K., & Philpott, C.,, 2021). The authors suggest that although no Covid-19 pneumonia studies met their inclusion criteria, that existing evidence suggests that hydration is equally as important for Covid-19 pneumonia mortality risk (L. Hooper, Abdelhamid, A., Ajabnoor, S., Bassey, C., Brainard, J., Brown, T. J., Bunn, D., Foster, E., Hammer, C. C., Hanson, S., Jimoh, F, O., Maimouni, H., Sandhu, M., Winstanley, L., Cross, J. L., Welch, A. A., Rees, K., & Philpott, C.,, 2021).

This systematic review aims to investigate any effect of Covid-19 public health measures on dehydration prevalence for older adults.

Measures of dehydration

Dehydration continues to be measured, in current practice, using a variety of inaccurate tests for older adults, despite recommendations to use serum osmolality (L. Hooper et al., 2015; S. J. C. Paulis, Everink, Halfens, Lohrmann, & Schols, 2018; Simone J. C. Paulis et al., 2020; Volkert et al., 2019). Serum osmolality of ≥300mOsm/kg is considered the reference standard for diagnosing low-intake dehydration (L. Hooper, Bunn, Jimoh, & Fairweather-Tait, 2014), though it is widely recommended that a less invasive indicator of dehydration needs to be developed (D. K. Bunn & Hooper, 2019; L. Hooper et al., 2015; Simone J. C. Paulis et al., 2020). There is large variance in the way that dehydration is measured for hospitalised older adults (Bennett, Thomas, & Riegel, 2004; A. M. El-Sharkawy, Sahota, O., Maughan, R. J., & Lobo, D. N., 2014; Glover et al., 2014), which raises issues as to how studies can be compared, and for how dehydration can be assessed and interpreted for clinical and research purposes. It is expected that there is even more variance in how low-intake dehydration is measured globally, as some countries will not have the infrastructure or finances to routinely measure serum osmolality in practice; this is also the case for some settings within the UK. Serum osmolality is expensive, requires more resources in laboratories, compared with routine blood tests, and is also an invasive measure of dehydration (Lee Hooper et al., 2015). A systematic review of 67 minimally invasive tests of dehydration concluded that there was “no clear evidence” (L. Hooper et al., 2015, p. 25) that any accurately measured dehydration; these tests included urinary markers and commonly reported physical signs and clinical symptoms.

Due to the lack of diagnostic inaccuracy of signs and symptoms of low intake dehydration studies using these measures will not be included in this review; instead, the review will include those tests and measures which are routinely used for clinical and research purposes, as well as the reference standard measures. These include serum/ plasma osmolality as the reference standard measure of low-intake dehydration for older adults (Volkert et al., 2019); it is generally accepted that plasma osmolality is deemed equivalent to serum osmolality (Lee Hooper et al., 2015). This review will also include calculated serum/plasma osmolarity as a predictor of directly measured serum/plasma osmolality. Calculated serum/plasma osmolarity is a more feasible and cost-effective measure for assessing low-intake dehydration, as it uses values obtained from a routine blood test, which can be processed by any laboratory (Lee Hooper et al., 2015). There are a number of equations in use clinically, however the Khajuria and Krahn calculated osmolarity equation has been found to predict directly measured serum/plasma osmolality most accurately, in older adults (Lee Hooper et al., 2015). Low intake dehydration is caused by reduced fluid intake (Volkert et al., 2019) and thus fluid charts are routinely completed in care settings, to easily record fluid intake. Researchers also frequently use fluid intake to assess low-intake dehydration, however there has been a high risk of bias found in studies measuring fluid intake, due to the wide variation in how fluid intake is reported, the difference in definitions of fluids, and how they are measured (D. Bunn et al., 2015). One care home study found that self-report methods of fluid intake were more accurate, than staff reports, when compared with researcher observation (Jimoh, Bunn, & Hooper, 2015). This review will include fluid intake as a measure of low-intake dehydration, as it aims to obtain a representative set of data globally, across settings, large enough to yield a useful synthesis, where serum/plasma osmolality might not routinely be measured. Subgroup analyses will then be conducted to investigate any methodological heterogeneity resulting from the different measures of dehydration.

Although creatinine-based measures have been found to lack specificity in measuring dehydration, particularly among older adults with impaired renal function (L. Hooper et al., 2016), they are routinely used to assess dehydration for clinical and research purposes, and thus BUN: Creatinine ratio will also be included in this review as it will yield enough data for synthesis; once again, any heterogeneity will be investigated. However, no other urinary markers will be included in this systematic review, as they rely on normal kidney function to detect dehydration (Lee Hooper et al., 2016). A diagnostic accuracy study investigating the utility of urinary markers for measuring dehydration, in two cohorts of European older adults, found that no markers were useful in older adults, due to reduced kidney function in older ages (Lee Hooper et al., 2016). A diagnostic accuracy study using data from adults over 60 admitted to hospital for emergency or acute medical care, found that physical signs, urine indices and simple saliva indices were not accurate at detecting dehydration for this population (Fortes et al., 2015). However, the study did find that saliva osmolality could detect dehydration for their sample of hospitalised older adults (Fortes et al., 2015). Saliva osmolality will thus be included in this review, as it is a commonly used measure of low-intake dehydration and shows promise for use with older adults (Fortes et al., 2015; J. C. Mentes et al., 2019). A more recent diagnostic accuracy study found that saliva osmolality demonstrated a moderate degree of diagnostic accuracy, detecting water loss dehydration in 69% of older adults admitted to hospital (Fortes et al., 2015). Another study assessing low-intake dehydration using salivary osmolality for community-dwelling older adults (J. C. Mentes et al., 2019), found similar salivary osmolality values to those of Fortes et al., (2015), providing further evidence for its utility.

For the purposes of clarification, within this systematic review, serum/plasma osmolality will be deemed the most robust measure of hydration status for older adults (Volkert et al., 2019). Calculated serum/plasma osmolarity, using the Khajuria and Krahn equation will be deemed the next robust measure, given the fact it was found to best predict directly measured serum/plasma osmolality (Lee Hooper et al., 2015). Saliva osmolality will be considered the next most robust measure, due to its promising diagnostic accuracy for assessing low-intake dehydration in older adults (Fortes et al., 2015; J. C. Mentes et al., 2019). Any other equation of calculated serum/plasma osmolality will then be regarded as the next most robust measure, as there is question over how well most equations predict directly measured serum/plasma osmolality (Lee Hooper et al., 2015). Fluid intake will be the next most robust measure, and BUN:Cr will be regarded as the least robust measure to assess low-intake dehydration in older adults, due to urinary markers not being accurate among older adults (Lee Hooper et al., 2016; L. Hooper et al., 2016).

Inclusive Involvement in Health Research

Patient and public involvement is “research carried out ‘with’ or ‘by’ members of the public” (NIHR INVOLVE, 2021), where they are actively involved in the development of research. Public involvement includes people who use health and social services, and also organisations who represent people using those services (NIHR INVOLVE, 2021). There is a wealth of evidence that highlights the positive impact of patient and public involvement on health research, which includes making research more cost-effective by not wasting resources, improving the quality of research, giving a voice to marginalised groups, creating positive change in communities and highlighting new areas for research (Baldwin, Napier, Neville, & Wright-St Clair, 2018; Miah et al., 2019; Pii, Schou, Piil, & Jarden, 2019). The benefits for people being involved in PPI, included personal development (ie. confidence and feeling valued), enjoyment, developing social relationships and experiencing learning opportunities (Baldwin et al., 2018; Miah et al., 2019). However, certain negative impacts

have also been highlighted by PPI members: demanding workloads, difficulty managing relationships with team members and dissatisfaction with level of involvement (Baldwin et al., 2018). Despite the evidence highlighting the positive impact of public involvement in health research, it is not always carried out as part of research projects (Cook, Siddiqi, Twiddy, & Kenyon, 2019; Miah et al., 2019). Even when public involvement is used to inform health research, it is not often reported in published materials (Cook et al., 2019; Miah et al., 2019). If PPI is reported, it is often from the researcher's perspective and does not feedback the impact from the PPI members' perspective (Cook et al., 2019). This proposed systematic review will report on the proportion of included studies which involve and report on patient and public members in their research, and the positive and negative impacts of this.

Existing systematic review investigating dehydration prevalence

Paulis et al. (2018) conducted a systematic review and reported dehydration prevalence rates of between 0.8-38.5% for nursing home and institutionalised long-term care residents. Paulis et al.'s (2018) systematic review included 19 studies; of which four measured dehydration using serum osmolality, which is the reference standard for measuring low-intake dehydration. The authors grouped studies using a variety of measures of dehydration, measuring different types of dehydration, into the synthesis, which resulted in large heterogeneity. The review authors concluded that a meta-analysis was not feasible due to the presence of heterogeneity. However, the sources of heterogeneity could have been investigated by conducting subgroup analyses and subgrouping by measures/diagnosis of dehydration. A random-effects meta-analysis could have been attempted for the prevalence data for the four studies which included serum osmolality in the systematic review, however this was not detailed by the authors. There are now questions around the diagnostic accuracy of measures of dehydration (L. Hooper et al., 2015), and thus in light of these developments in the field, there is a need to conduct a new systematic review for the prevalence of dehydration, using robust measures. The present systematic review additionally aims to collect data on community dwelling older adults.

Why is it important to do this review?

A systematic review is required to accurately establish the prevalence of dehydration globally, and between settings, in order to implement interventions at appropriate levels for those 'at risk' settings, to ultimately reduce dehydration and prevent the avoidable hospitalisations, concurrent health conditions and mortalities amongst older adults that may be linked to dehydration. Many studies have reported prevalence rates of dehydration in the literature, using a variety of different measures and ineffective clinical signs and symptoms. A systematic review is required to collate all the data using more reliable measures of dehydration, in order to establish an accurate picture of the issue for older adults around the world, which will consequently inform policies, clinical practice and interventions to prevent dehydration. An accurate prevalence rate is also necessary to calculate an accurate costs analysis of dehydration, which is currently thought to be underestimated (J. C. Mentes et al., 2019).

In conclusion, dehydration needs to be measured in a more robust manner, using a robust measure, so that dehydration prevalence can be accurately measured and compared across settings and countries, which will then highlight areas of concern, to enable implementation of interventions to improve dehydration. Consequently, this systematic review and meta-analysis aims to assess the prevalence of dehydration among adults over the age of 65 years old, across settings, across countries and across comorbidity groups.

Questions to be addressed:

1. What is the prevalence of low-intake dehydration among adults aged ≥65 years?
2. What is the prevalence of low-intake dehydration among adults aged ≥65 years living in different settings?
3. What is the prevalence of low-intake dehydration among adults aged ≥65 years living with renal impairment, cognitive impairment and/or diabetes?
4. What is the prevalence of low-intake dehydration among adults aged ≥65 years living in high income, middle income and low income countries?
5. What is the prevalence of low-intake dehydration among adults aged ≥65 years with varying levels of dependency on others, to meet their hydration care needs?
6. What is the association between the prevalence of low-intake dehydration among adults aged ≥65 years, and percentage of care staff who are registered nurses?
7. What is the association between the prevalence of low-intake dehydration among adults aged ≥65 years, and the ratio of care staff to older adults.
8. Have the included studies involved patient and public involvement in their research? What was the impact of their PPI?
9. What effects have Covid-19 public health measures had on prevalence of low-intake dehydration in adults aged ≥65 years?
10. What proportion of participants were female and/or from a BAME community, and/or lacking mental capacity?

Aim and Objective

The overall aim of this systematic review is to establish the prevalence of low-intake dehydration among adults aged ≥65 years.

The objective of this review is to establish the prevalence of low-intake dehydration using robust measures of dehydration, for adults aged ≥65 years using systematic review methodology for prevalence studies (Higgins, 2019; Munn, 2015).

The review will also assess whether the prevalence of low-intake dehydration for adults aged ≥65 years, is affected by care setting, comorbidity, dependency on others for hydration care, staff skill mix and staffing ratio of care provision, and the economy of the country of study. It aims to report on the proportion of included participants who are female and/or from a BAME community, and/or lacking mental capacity. The review also aims to establish any effect of Covid-19 public health measures on the prevalence of low-intake dehydration for adults aged ≥65 years. The systematic

review will also report on PPI involvement in any of the included studies, and the impact of the involvement.

Methods

This protocol has been reported in line with PRISMA-P 2015 guidelines (D. Moher, Shamseer, L., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., Shekelle, P., Stewart, L. A., 2015), and the systematic review will follow the methodology outlined in the Cochrane Handbook for Systematic Reviews of Interventions (Higgins, 2019). Data synthesis will be informed using guidance from the 'Conducting and reporting systematic reviews of prevalence and incidence data' chapter of the Joanna Briggs Institute Manual for Evidence Synthesis (Aromataris, 2020, pp. 202-205).

Eligibility Criteria

Inclusion Criteria- We will include any study, including at least 5 participants, which reports a prevalence of low-intake dehydration in adults 65 and over:

- Participants: Adults with a mean age of ≥65 years of age, or at least 80% of participants are aged 65 and over, in any setting (including free living, residential care, hospital etc), in any part of the world, receiving fluids by any means (enterally fed and nasogastric tube fed older adults will be included, due to research suggesting that these individuals might also be at risk of dehydration (Dyck, 2004; Kayser-Jones et al., 1999; Leibovitz et al., 2007)).
- Exposure: Low-intake dehydration as measured by serum/plasma osmolality, calculated serum/plasma osmolarity (any equation), fluid intake, saliva osmolality and/or BUN:Creatinine ratio.
- Study type: Case studies, cross sectional studies, cohort studies, case-control studies, randomised controlled trials, controlled clinical trials, before-after studies, not restricted by publication status, language or date of publication.

Exclusion Criteria

- Anyone under the age of 65 years/mean age <65yrs/>80% <65yrs.
- Any measure of dehydration not listed in the inclusion criteria.
- Salt loss dehydration
- Studies addressing fluid intake, exclusively relating to alcohol intake.
- Case studies with fewer than 5 participants.
- Any study not reporting a prevalence rate of low-intake dehydration.
- Any study reporting on the prevalence of dehydration, exclusively for those receiving end of life care (hydration care provision for these individuals is expected to be different to the general population).

Primary Outcomes

The primary outcomes for this review are the following:

1. Prevalence of low intake dehydration, as measured by directly measured serum/plasma osmolality.
2. Prevalence of low intake dehydration, as measured by calculated serum/plasma osmolarity (only where equations have been provided).
3. Prevalence of low intake dehydration, as measured by saliva osmolality.
4. Prevalence of low intake dehydration, as measured by BUN:Creatinine.
5. Prevalence of low intake dehydration, as measured by fluid intake.

Studies will be excluded which do not mention the above-mentioned outcomes.

Search methods for identification of studies

Information Sources

Relevant studies will be identified using a structured search process, as described in the Cochrane Handbook of Systematic Reviews of Interventions (Higgins, 2019). Data will be searched from the following databases: Medline-Ovid, Cochrane CENTRAL, Embase (Ovid), CINAHL Complete, Proquest Dissertations & Theses A&I and Nutrition & Food Sciences, from inception until June 2021, with no restriction on language of publication. Grey literature and unpublished data will also be sought by contacting Authors and Researchers in the field and by searching Proquest. The bibliographic reference lists of included studies, and of relevant systematic reviews, will also be searched for their application to the inclusion criteria. The search will be as extensive as possible to reduce the risk of publication bias.

Search Strategy

The initial search will be run on Medline-Ovid, using a combination of MeSH and free text terms to conduct a comprehensive search. The search will combine Boolean operators, wild cards and truncation, and proximity operators. The final search strategy was developed through an iterative process to increase the comprehensiveness of the search, in order to aim for maximum sensitivity and precision, ensuring that the search retrieved key publications on low-intake dehydration in older adults. The search strategy was developed in line with the PRESS checklist, in order to ensure a complete and adequate search (McGowan et al., 2016). The search strategies used for Embase, Medline-Ovid and Cochrane CENTRAL have been copied and pasted into the Appendices, in order to ensure transparency and to facilitate the replicability of the search. The search strategy for Embase and Medline-Ovid used an adapted search filter, to search for humans, using the “Cochrane highly sensitive search strategies for identifying randomized trials”, as described in Section 3.6 of the Supplementary material 4.S1 in the Cochrane handbook (Lefebvre, 2020). The search strategy has been reported in line with the PRISMA-P, but more specifically in line with the PRISMA-Search extension guidelines (Rethlefsen, 2020).

The full search strategy for Medline-Ovid can be found in Appendix 2, and follows the following format:

[aged] and [prevalence or incidence] and [dehydration or fluid] and [human]

The search strategy was peer-reviewed by a member of the review team, using the PRESS checklist (McGowan et al., 2016), to improve the quality of the searches. Suggested improvements were implemented, and the search strategy was adapted to fit the formats for each database. There were no limitations on the dates of publication/study undertaken. The lead reviewer will also run the developed search in each database, to be notified of any new studies which meet the review eligibility criteria, prior to publication, to ensure that the review is up to date. A study will be noted on the review if it is registered, ongoing or complete but has not yet reported findings.

Data Collection and Analysis

Selection of Studies

The 'study inclusion' form assesses study inclusion against the eligibility criteria and has been developed in draft (See Appendix 8). The 'study inclusion' form will be piloted initially by the review team on 200 titles and abstracts, to test the eligibility criteria, then updated to incorporate refinements, thus ensuring that the consistency of inclusion assessment is maintained, and quality ensured.

Titles and abstracts will be exported from the relevant databases, into Covidence review management software. Any duplicate studies from different data sources will be removed. Two reviewers will independently screen all titles and abstracts produced from the search, in duplicate, using the 'study inclusion' form. The lead reviewer will review all titles and abstracts, and then all titles and abstracts will be divided up between the review team to review. If a study appears to meet all aspects of the inclusion criteria, or there is some uncertainty about a study's eligibility, then a full text version will be retrieved. Inclusion of full text papers will be assessed independently in duplicate, in Covidence, by the same reviewers screening titles and abstracts. Any discrepancies between reviewers will be arbitrated by a third independent reviewer. Any titles and abstracts co-authored by members of the review team, will be independently screened by two additional reviewers, to assess for study inclusion. The independent reviewers will also assess, independently in duplicate, the inclusion of any full text papers co-authored by any of the review team. Any disagreements about the eligibility of a full text for inclusion within the review, between reviewers, will be arbitrated by resolved by discussion between the reviewers in the first instance. If it's unable to be resolved between reviewers, then inclusion will be arbitrated by discussion with a third independent reviewer. Multiple reports of the same study, from different sources, will be de-duplicated and combined within Covidence, in preparation for data extraction.

A PRISMA flowchart will be devised to illustrate the study selection process, with figures on included and excluded studies, using Covidence (D. Moher, Liberati, A., Tetzlaff, J., Altman, D. G., THE PRISMA GROUP., 2009). Once all full texts have been retrieved, a list of excluded studies will be compiled, with explanations of why each study was excluded, and did not meet the inclusion criteria.

Data Extraction and Management

The 'data extraction and risk of bias form' form was developed in draft (See Appendix 9) and will collect data on the following:

1. Study Details: Author, year of publication, journal, article title, study design, any other documents related to that study (for multiple study reports), country of origin, language, source of funding, details of ethics, PPI involvement.
2. Study Characteristics: Aim, design, setting, quality of evidence (devised from risk of bias table), study inclusion/exclusion criteria, sample size, recruitment process.
3. Participant characteristics: Age, gender, ethnicity, primary diagnosis(es), care setting, comorbidity, economy of country of study, staff skill mix of care provision, ratio of staff to older adult sample, dependency on others to meet hydration care needs, Impact of Covid-19 public health measures.
4. Outcomes: Dehydration prevalence (number of participants dehydrated from sample, total sample size, measure of dehydration used, cut off used to assess dehydration).

The ‘data extraction and risk of bias’ form (Appendix 9) will be piloted by all reviewers on five full texts to ensure data quality and consistency between reviewers on the interpretation of the data to be extracted. Risk of bias assessments will also be piloted for the five full text papers. Any discrepancies will be discussed, and forms adjusted where needed. A third independent reviewer will also be able to arbitrate if required. Any papers co-authored by the review team, will be screened and data extracted by independent reviewers. Once piloting is complete, data extraction will be carried out by a minimum of two independent reviewers. The lead reviewer will review all full texts and then all full texts will be divided up between the review team to review, for data extraction.

For all included studies, all relevant data will be extracted into Microsoft Excel, based on the ‘data extraction and risk of bias form’, in preparation for synthesis. Any errata or retraction statements will be reviewed for relevant information. Study authors will be contacted by the lead reviewer should any missing information be required, or any misunderstandings about the study’s eligibility, or if further clarification is required. Any discrepancies not resolved between the two reviewers, regarding data extraction, will be discussed with a third independent reviewer for arbitration. Reviewers will then screen the reference lists of all included studies, and check references for eligibility, in Covidence. Unpublished, eligible data will also be put into Covidence. Details of any ongoing or completed studies, which have yet to provide results, will be recorded.

Assessment of risk of bias in included studies

Each included study will be critically appraised by two independent reviewers, using the Joanna Briggs Institute (JBI) ‘Checklist for prevalence studies’, in order to assess the methodological quality of each study, and identify any resultant biases (Munn, 2015). The JBI ‘Checklist for prevalence studies’ will be used, due to the variety of study designs used to report prevalence data, and these details will be inputted onto the ‘data extraction and risk of bias’ form for each included study.

The risk of bias form will be completed independently by each reviewer during data extraction of each full text. Reviewers will then discuss risk of bias together and assess a final agreed risk of bias for each study. The three most important categories for risk of bias, for this review, are:

1. Was the condition measured in a standard, reliable way for all participants?
2. Were study participants recruited in an appropriate way?
3. Were the study subjects and setting described in detail?

Studies will be assessed as low risk of bias, if the three aforementioned categories of the ‘risk of bias’ table are agreed to be low by both reviewers, and high risk of bias if the three aforementioned categories are agreed to be high risk of bias. The question: “Were valid methods used for the identification of the condition?” was removed, from the risk of bias form, as all methods of dehydration assessment have been considered to be satisfactory, in order to meet the review’s eligibility criteria.

Risk of bias data will then be transcribed into risk of bias tables on Covidence.

Measure of prevalence data

Prevalence data will be reported as proportions, as either a continuous number or a percentage (or both), with 95% confidence intervals. If a meta-analysis is feasible, the proportions will be

transformed first using the Freeman-Tukey transformation (arcsine square root transformation) (Aromataris, 2020), prior to conducting meta-analyses.

Dealing with missing data

Authors will be contacted wherever possible to obtain missing data required for outcomes or for the conduction of a meta-analysis, in order to reduce publication bias. Data will be explored in order to assess the source of the missing data and explanations provided as to how this might impact on the findings of the review (Higgins, 2019)

Assessment of heterogeneity

If clinical heterogeneity allows, data will be pooled and investigated by visually assessing the forest plot.

Data will be checked for inaccuracies or errors, and analyses will be re-run if data have been entered in error.

Heterogeneity will then be investigated using the I^2 statistic, as it reflects the variability of effect sizes caused by heterogeneity rather than sampling error (Higgins, 2019). Heterogeneity will be assessed as being high if I^2 is ≥60% (Higgins, 2019).

However, even when I^2 is <60%, possible causes of the heterogeneity should always be investigated; this could be caused due to differences in measures assessing dehydration, care setting of participants and/or participant characteristics (clinical heterogeneity) (Gagnier, Moher, Boon, Beyene, & Bombardier, 2012). Subgroup analyses and meta-regression will be conducted to investigate the sources of clinical heterogeneity, specifically for care settings, measures of dehydration and some participant characteristics; further details are included in the 'subgroup analysis' section further below (Aromataris, 2020; Gagnier et al., 2012; Higgins, 2019).

If subgroup analyses identify that some measures assessing dehydration are too different to be combined, then the measure with the largest number of studies will be selected to be run for the meta-analysis. Serum/plasma osmolality and serum/plasma osmolarity could also be combined to create one measure and be used for the meta-analysis.

Assessment of reporting biases

Reporting bias (publication bias) will be explored by creation of a funnel plot; if no bias is detected, then the funnel plot will appear symmetric and inverted (Aromataris, 2020; Higgins, 2019). Any known missing data will be noted (eg. A protocol states that dehydration prevalence was assessed, but no findings reported in the publication, or reported in a way that cannot be combined in meta-analysis).

Data synthesis

Data synthesis will be informed by the 'Conducting and reporting systematic reviews of prevalence and incidence data' chapter of the Joanna Briggs Institute Manual for Evidence Synthesis (Aromataris, 2020, pp. 202-205), as there is no other clear guidance advising on data synthesis specifically for prevalence studies.

Data will firstly be examined prior to statistical synthesis, for errors and missing data. All data for the review will be presented in tables and graphs in a reader-friendly manner.

A meta-analysis is planned to statistically synthesise the results of this systematic review for the primary outcomes, depending on the number of studies available for the meta-analysis and the existence of heterogeneity. The meta-analysis aims to estimate overall prevalence of dehydration. Revman will be used to conduct any meta-analyses.

Once heterogeneity has been examined and investigated (as discussed earlier), a random effects meta-analysis will be employed, to allow for variation in study population sizes and unexplained heterogeneity (Deeks, 2020; Higgins, 2019). The proportions and 95% confidence intervals for each study will firstly be transferred to Microsoft Excel and then transformed using the Freeman-Tukey arcsine square root transformation to calculate the weighted summary proportion under the random effects model, in order to give pooled proportions with 95% confidence intervals for each included study (Aromataris, 2020). The pooled proportions will then be entered into RevMan under the 'genetic inverse variance' outcome, to conduct a random-effects meta-analysis. This will then provide an overall percentage for people dehydrated across all included studies. A forest plot will be used to illustrate the pooled proportions with 95% confidence intervals, as well as of each included study. A Galbraith plot will be used to illustrate the extent of heterogeneity between studies in the meta-analysis and a Cumulative plot will be used to display incidence and prevalence estimates (Deeks, 2020).

The main analysis will include all measures assessing dehydration, included in the review for older adults, subgrouped by measures of assessments of dehydration (as detailed in the primary outcome section). These subgroups will be combined (totalled at the bottom of the forest plot) if there are not statistically significant differences between the subgroups. If there are significant differences between the subgroups, then only the subgroups will be totalled. Only one measure of dehydration will be selected from each study to go into the analysis. If a study reports multiple measures of dehydration, then the rank order for robustness of dehydration measure will be used, (as discussed in the measures section of the introduction), to select which measure will be used from each study.

From this point onwards the measures of hydration will only be combined if there are not clear differences between subgroups.

If a meta-analysis is not feasible, due to a low number of included studies, too much missing outcome data, too much bias or high levels of heterogeneity (Higgins, 2019), then the data will be narratively synthesised. The narrative synthesis will look at the association between all study outcomes and the prevalence of low-intake dehydration, in accordance with SWiM (M. Campbell et al., 2020) and PRISMA (D. Moher, Liberati, A., Tetzlaff, J., Altman, D. G., THE PRISMA GROUP., 2009) reporting guidelines, as well as following the guidance provided by the JBI manual for presenting a narrative synthesis (Munn, 2015). Sources of heterogeneity and risk of biases will be discussed and explanations provided for why data could not be combined statistically.

Subgroup analysis and investigation of heterogeneity

The following subgroup analyses are planned *(Definitions for each factor are provided in Appendix 1)*:

1. **Risk of bias:** i. studies at low risk of bias, ii. Studies at high risk of bias
2. **Care setting:** i. Community living with no formally identified care needs, ii. Community living with formal/paid care, iii. Hospital for a medical/stabilisation purpose, for acute care, with a planned end date, iv. Long term care home/facility
3. **Comorbidity- Diabetes:** i. diabetes, ii. No diabetes

4. **Comorbidity-Cognitive Impairment:** i. cognitive impairment, ii. No cognitive impairment
5. **Comorbidity- Renal Impairment:** i. renal impairment, ii. No renal impairment
6. **Comorbidity – Mixed:** i. ≤ 2 comorbidity, ii. > 2 comorbidity
7. **Staff skill mix of care provision:** i. percentage of nursing professionals, ii. Percentage of personal care workers *(median cut off will be calculated for percentage data, and then allocated to either group, depending on the value being higher or lower than the mean)*
8. **Care staff to older adult ratio**: i. higher staff to older adult ratio, ii. Lower staff to older adult ratio *(median cut off will be calculated for ratio data, and then allocated to either group, depending on the value being higher or lower than the mean)*
9. **Dependency on others, to meet hydration care needs:** i. Functionally independent, ii. Semi-independent, iii. Total dependence on others, iv. Mixed dependency, v. Unclear Dependency level
10. **Economy of country of study:** i. High income, ii. Upper-middle income, iii. Lower-middle income, iv. Low income
11. **Impact of Covid-19 public health measures:** i. studies conducted pre-Covid-19, ii. studies conducted during Covid-19 pandemic.

Definitions for all qualities used to define subgroups within this review are detailed in Appendix 1.

Should data and sample size allow (≥10 studies per predictor variable) (Gagnier et al., 2012; Higgins, 2019), Random-effects meta-regressions will be conducted to investigate any statistically significant differences between the following groups, on the prevalence of dehydration (above/below median cut off of each dehydration measure, depending on the measure):

1. Percentage of nursing staff (%)

If there are enough studies for the meta-regression to be run (≥10 studies per predictor variable) (Gagnier et al., 2012; Higgins, 2019), then the following variables will also be investigated:

2. Percentage of participants with cognitive impairment (%)

Sensitivity analysis

The following sensitivity analyses will be conducted, including only:

1. Studies using either serum/plasma osmolality or the Khajuria and Krahn equation of serum/plasma osmolarity (Lee Hooper et al., 2015; Siervo, Bunn, Prado, & Hooper, 2014) to measure low-intake dehydration.
2. Studies at low risk of bias

Summary of findings and assessment of the certainty of the evidence

The 'Summary of findings' table will use the GRADE approach to evaluate the quality of data retrieved from the systematic review (Ryan, 2016). The table will include all outcomes and the number of studies, their study designs and number of participants within each outcome, as well as the overall quality of evidence provided for each outcome, as assessed by the GRADE approach (Ryan, 2016). The quality of the evidence will be independently rated by two reviewers and a third independent reviewer will be used to mediate disagreements and arbitrate where necessary.

A 'characteristic of included studies' table will be created to provide an overview of the details of the included studies. The 'characteristics of included studies' table will inform the 'risk of bias' table. A 'characteristics of excluded studies' table will finally be created for studies where full text articles were sought, but after full text review, were deemed not to meet the review's requirements.

Dissemination strategy

We will report the systematic review in line with PRISMA guidelines (D. Moher, Liberati, A., Tetzlaff, J., Altman, D. G., THE PRISMA GROUP., 2009) and publish them in a relevant peer-reviewed journal. We will also disseminate the systematic review findings at topic- and practice-relevant conferences, in the form of posters or presentations, or both, and develop an infographic to be shared on social media. We will also share the findings in a press release.

Ethical issues

This systematic review protocol will be published on PROSPERO so as to transparently convey what this systematic review aims to achieve. The review will be conducted in line with COCHRANE methodology (Higgins, 2019), using guidance from Joanna Briggs Institute for the data analysis section (Munn, 2015), to ensure the highest quality of data collection, extraction and analysis. All stages of the review will be duplicated to minimise bias and enhance transparency. Independent reviewers will screen and data-extract any papers co-authored by members of the review team, in order to minimise bias. Formal ethical review is not required for this systematic review, as all published studies involving human participants should have sought the appropriate ethical approval prior to conducting research. Details of each study's funding and ethics will be sought for inclusion in the 'characteristics of included studies' table.

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APPENDIX 1: Categories for further analyses for the systematic review

Dehydration	***Serum/ Plasma Osmolality -*** dehydration as measured by serum/plasma osmolality with any cut off.	***Calculated Serum/Plasma Osmolarity –*** An estimate of directly measured serum/plasma osmolality using any reported equation using sodium, potassium, urea and glucose. (Authors will be contacted to obtain equations, when they are not provided).	***Fluid Intake -*** dehydration as measured by not meeting fluid intake requirements, with any cut off, time frame or method used to measure	***BUN:Cr*** - dehydration as measured by BUN: Creatinine with any cut off	***Saliva Osmolality –*** dehydration as measured by saliva osmolality with any cut off
Care Setting	***Community living with no formally identified care needs–*** either no care needs or no care reported.	***Community living with formal/paid care –*** Sheltered/warden-controlled housing or own home with paid care. Includes people who attend day care but reside at home still.	***Hospital for a medical/stabilisation purpose, for acute care, with a planned end date–*** Admitted to hospital to receive a medical intervention (e.g fall/ UTI/ psychiatric symptoms) and not for a long term residential purpose	***Long term care home/facility –*** Long term residence due to extra care needs and support being required.	
Comorbidity – groups identified from the UK DRIE study (L. Hooper et al., 2016)	***Renal impairment*** – as defined by study authors	***Cognitive Impairment***– as defined by study authors	***Diabetes***– as defined by study authors	**Mixed Comorbidity –** combination of any of the 3 comorbidities: renal impairment, cognitive impairment, or diabetes	
Economy of country of study – World Bank classification (The World Bank Group, 2020)	***High Income –*** World Bank's GNI per Capita definition at the time of the year of study (1990 onwards)	***Upper-middle income-*** World Bank's GNI per Capita definition at the time of the year of study (1990 onwards)	***Lower-middle Income -*** World Bank's GNI per Capita definition at the time of the year of study (1990 onwards)	***Low Income*** - World Bank's GNI per Capita definition at the time of the year of study (1990 onwards)	

Staff skill mix of care provision – percentage of care/nursing staff, which makes up care/nursing team.	***Personal care worker in health services*** – "provide direct personal care services in healthcare and residential settings" (World Health Organization, no date, p. 10)	***Nursing professional –*** "requires formal training at a higher institution in nursing" (World Health Organization, no date, p. 3)			
Care staff to older adult ratio – ratio of care/nursing staff to older adult ratio	***Higher staff: older adult ratio –*** (higher than the mean ratio)	***Lower staff: older adult ratio-*** (lower than the mean ratio)			
Dependency on others, to meet hydration care needs – groups identified from Gaspar's study (Gaspar, 1988). These groups of older adults exist within all care settings, and so its inclusion will enable us to tease out factors relating to settings, or factors relating to functioning, which might affect dehydration prevalence.	***Functionally independent*** – cognitively able and mobile (Gaspar, 1988)	***Semi-independent –*** Gaspar's (1988, p.223) definition – "cognitively unaware of needs, yet have mobility, and those physically unable to meet their needs but who abandon expressing them" – Require assistance making drinks and reminders to drink.	***Total dependence on others*** – need assistance with drinking and preparation of drinks, or dependence on PEG/NG tube for fluids.	**Mixed Dependency–** Mixed dependency level	**Unclear Dependency–** Dependency level not provided by study authors or unclear
Impact of Covid-19 public health measures	***Pre-Covid-19 -*** studies conducted prior to 2020 worldwide spread of pandemic	***During Covid-19***- studies conducted during Covid-19 pandemic from 01/01/2020 onwards.			

Appendix 2 (Search strategy – Medline - Ovid)

[aged] and [prevalence or incidence or epidemiology] and [dehydration or fluid]

Database: Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Daily and Versions(R) <1946 to February 01, 2021>

Search Strategy:

---

1 exp Aged/ or "aged, 80 and over"/ or frail elderly/ (3196847)

2 exp Incidence/ or exp Prevalence/ (546620)

3 exp epidemiology/ (27164)

4 (prevalen* or inciden*).ti,ab. (1629224)

5 2 or 3 or 4 (1806276)

6 exp Dehydration/ (13493)

7 exp Drinking/ or exp Beverages/ (154770)

8 (hydrat* or dehydrat* or euhydrat* or hypohydrat*).ti,ab. (102820)

9 ((drink* or beverage* or fluid* or water*) adj3 (intake* or consum* or lack* or defici* or provision*)).ti,ab. (44508)

10 (osmolarit* or osmolalit*).ti,ab. (23044)

11 ((BUN or urea*) adj3 (cr or creatinine)).ti,ab. (17650)

12 BUN?cr*.ti,ab. (18)

13 6 or 7 or 8 or 9 or 10 or 11 or 12 (327757)

14 exp animals/ not humans.sh. (4782806)

15 13 not 14 (235794)

16 1 and 5 and 15 (3826)

Appendix 3 – (Search Strategy - Medline – Embase)

[aged] and [prevalence or incidence] and [dehydration or fluid]

Database: Embase <1974 to 2021 February 03>
Search Strategy:
---

1 exp aged/ or aged hospital patient/ or frail elderly/ or institutionalized elderly/ or very elderly/ (3098023)
2 incidence/ (439108)
3 prevalence/ (758818)
4 2 or 3 (1142603)
5 exp dehydration/ (41692)
6 exp beverage/ (230966)
7 (hydrat* or dehydrat* or euhydrat* or hypohydrat*).ti,ab. (121534)
8 ((drink* or beverage* or fluid* or water*) adj3 (intake* or consum* or lack* or defici* or provision*)).ti,ab. (56961)
9 (osmolarit* or osmolalit*).ti,ab. (27305)
10 ((BUN or urea*) adj3 (cr or creatinine)).ti,ab. (27634)
11 BUN?cr*.ti,ab. (35)
12 5 or 6 or 7 or 8 or 9 or 10 or 11 (457284)
13 Animal experiment/ not (human experiment/ or human/) (2311211)
14 12 not 13 (409038)
15 1 and 4 and 14 (2715)

Appendix 4 – (Search Strategy – COCHRANE - CENTRAL)

[aged] and [prevalence or incidence] and [dehydration or fluid]

Search Name: Prevalence of Dehydration SR FINAL
Last Saved: 05/02/2021 13:29:26
Comment: 05.2.21

ID Search
#1 MeSH descriptor: [Aged] explode all trees
#2 MeSH descriptor: [Prevalence] explode all trees
#3 MeSH descriptor: [Incidence] explode all trees
#4 (prevalen* or inciden*):ti,ab
#5 #2 or #3 or #4
#6 MeSH descriptor: [Dehydration] explode all trees
#7 MeSH descriptor: [Drinking] explode all trees
#8 MeSH descriptor: [Beverages] explode all trees
#9 (hydrat* or dehydrat* or euhydrat* or hypohydrat*):ti,ab
#10 ((drink* or beverage* or fluid* or water*) NEAR/3 (intake* or consum* or lack* or defici* or provision*)):ti,ab
#11 (osmolarit* or osmolalit*):ti,ab
#12 ((BUN or urea*) NEAR/3 (cr or creatinine)):ti,ab
#13 BUN?cr*:ti,ab
#14 #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13
#15 #1 and #5 and #14

Appendix 5 – (Search Strategy –Proquest Dissertations & Theses A&I)

[prevalence or incidence] and [aged] and [dehydration or fluid]

Search Strategy

Set#	Searched for	Databases	Results
S3	S1 OR S2	ProQuest Dissertations & Theses A&I These databases are searched for part of your query.	76828
S4	TI,AB(aged)	ProQuest Dissertations & Theses A&I	41479
S5	TI,AB("older adult*")	ProQuest Dissertations & Theses A&I	11593
S6	TI,AB("over 65*")	ProQuest Dissertations & Theses A&I	871
S7	TI,AB(elder*)	ProQuest Dissertations & Theses A&I	21844
S8	TI,AB(aged) OR TI,AB("older adult*") OR TI,AB("over 65*") OR TI,AB(elder*)	ProQuest Dissertations & Theses A&I These databases are searched for part of your query.	69596
S9	TI,AB(dehydrat*)	ProQuest Dissertations & Theses A&I	6424
S10	TI,AB(fluid*)	ProQuest Dissertations & Theses A&I	87401
S11	TI,AB(hydrat*)	ProQuest Dissertations & Theses A&I	11518
S12	TI,AB(dehydrat*) OR TI,AB(fluid*) OR TI,AB(hydrat*)	ProQuest Dissertations & Theses A&I These databases are searched for part of your query.	102791
S13	(S1 OR S2) AND (TI,AB(aged) OR TI,AB("older adult*") OR TI,AB("over 65*") OR TI,AB(elder*)) AND (TI,AB(dehydrat*) OR TI,AB(fluid*) OR TI,AB(hydrat*))	ProQuest Dissertations & Theses A&I These databases are searched for part of your query.	80

Appendix 6 – (Search Strategy – CINAHL)

[prevalence or incidence] and [aged] and [dehydration or fluid]

#	Query	Results
S11	S3 AND S4 AND S10	946
S10	S5 OR S6 OR S7 OR S8 OR S9	47,400
S9	'TI' or 'AB' (hydrat*)	5,079
S8	'TI' or 'AB' (dehydrat*)	5,086
S7	'TI' or 'AB' (fluid*)	5,321
S6	(MH "Dehydration+")	4,214
S5	(MH "Beverages+")	38,463
S4	(MH "Aged+")	864,027
S3	S1 OR S2	6,389
S2	'TI' or 'AB' (incidence)	5,717
S1	'TI' or 'AB' (prevalence)	5,827

Appendix 7 – (Search Strategy – Nutrition and Food Sciences)

[prevalence or incidence] and [aged] and [dehydration or fluid]

ti OR ab: ((prevalence OR incidence) AND (aged OR elder* OR "older adult*" OR "over 65*")) AND (dehydrat* OR hydrat* OR "fluid intake*" OR beverage*))

1,949 results.

Appendix 8 – 'Study Inclusion Form'

[This form will be generated in Covidence]

Study ID will be created by using the first Author's surname and the year the first full report of the study was published e.g. Smith2001

Author (first 3 authors):_____

Year:_____

Journal:_____

Any study which ticks 'Yes' to all the questions below, will be included in the study.

1. Are the participants ≥65 years of age? (If not, is 80% of the sample ≥65 years of age? Or is mean age of sample ≥65 years)	**Yes/No**
2. Does the study include a minimum of 5 participants?	**Yes/No**
3. Does the study report a prevalence of low-intake dehydration, measured using any of the following? i. Serum/plasma osmolality ii. Calculated serum/plasma osmolarity (equations provided) iii. Saliva osmolality iv. BUN:Creatinine ratio v. Fluid intake	**Yes/No**

Any study which has question over its inclusion, and requires a full text paper for more information, circle 'pending'.

Any study which answers 'No' to any of the questions below, will be excluded from the study.

INCLUDE **EXCLUDE** **PENDING**

Reason for exclusion:

Reviewer:_____ **Date of Decision:**_____

Study ID:

Appendix 9 – 'Data Extraction and Risk of Bias' Form

Reviewer:_____ **Date of extraction:_____/_____/2021**

This form will be generated in Microsoft Excel

This form is only to be used for full texts, once studies have met the inclusion criteria and the full texts have been sought.

Study ID will be created by using the first Author's surname and the year the first full report of the study was published e.g. Smith2001

Please record any missing information as "missing", so that it's clear that you haven't forgotten to extract it.

	General Information
1. Author(s) *(up to first 3 authors)*	
2. Year Published	
3. Document Type *(eg. Journal/Conference Abstract…)*	☐ Journal Paper ☐ Conference abstract ☐ Conference proceedings ☐ Unpublished trial data ☐ Report ☐ Government publication ☐ Thesis ☐ Other:_____
4. Name of Journal	

5. Title of Article/Document/ Abstract *(Paper A)*				
6. Study Design	☐ Cross-sectional ☐ Case study ☐ Randomised Controlled Trial (RCT) ☐ Controlled Clinical Trial (CCT) ☐ Cohort study ☐ Case-control study ☐ Before-after study ☐ Other (provide details): _____			
7. Type of trial design *(If not a trial, tick 'non-trial')*	☐ Non-trial ☐ Parallel ☐ Crossover ☐ Cluster ☐ Factorial ☐ Other: _____			
		1st Author	**Title**	**Paper obtained? Y/N Reason if not.**
8. Further references to this study & identifying letter *(If a study has multiple reports published for it, list the additional reports/papers here)*	*Paper B*			
	Paper C			
	Paper D			
	Paper E			
	Paper F			
9. Country of Origin				
10. Language				

11. Source of Funding *(Inc. role of funders)*		Page #: _____ Para #: _____ Figure: _____ Table: _____
12. Details of Ethics	☐ Ethical approval documented ☐ Informed consent process documented **Details:**	Page #: _____ Para #: _____ Figure: _____ Table: _____
13. Were patients and public (PPI) involved in the research at any capacity?	☐ No ☐ Yes – **give details below:**	Page #: _____ Para #: _____ Figure: _____ Table: _____

	Study Characteristics	**Location of support in document** *(Page #, Paragraph # on that page, Table or figure)*
14. Aim of Study (Copy and paste here)		Page #: _____ Para #: _____ Figure: _____ Table: _____
15. Data Collection start and end date	Start Date: ____/_____/_____ End Date: _____/_____/_____	Page #: _____ Para #: _____ Figure: _____ Table: _____

(Start and End of trial/ intervention, participation etc.)		
16. Quality of evidence (Input from Risk of bias table below)	Risk of bias rating given: ☐ High ☐ Low	
	Evidence for judgement:	Page #: _____ Para #: _____ Figure: _____ Table: _____
17. Study inclusion/exclusion criteria	**Inclusion:**	Page #: _____ Para #: _____ Figure: _____ Table: _____
	Exclusion:	Page #: _____ Para #: _____ Figure: _____ Table: _____
Sample size:	# of relevant people/sample available (in setting): # assessed as eligible: # recruited to study: # people excluded/ dropped out: # participants with dehydration data: # participants in final analysis:	Page #: _____ Para #: _____ Figure: _____ Table: _____

18. Recruitment process	**Details:**		Page #: _____ Para #: _____ Figure: _____ Table: _____
19. Participant characteristics	**Age**	Mean age: median age: Measure of variance (SE / SE / 95% CI / IQ range): Age range included:	Page #: _____ Para #: _____ Figure: _____ Table: _____
	Sex (#, % of total sample)	**Circle:** All male / all female / mixed ---------- Male (#, %): Female (#, %):	Page #: _____ Para #: _____ Figure: _____ Table: _____
	Ethnicity (#, % of total sample)	Provide details for each ethnic group reported within sample:	
	Any excluded Populations from the study? (describe popn, # of excluded pts & % out of total popn)	Excluded Group: Number: Proportion out of total popn:	Page #: _____ Para #: _____ Figure: _____ Table: _____
	Primary Diagnosis(es) (Do the participants have	**Circle:** All had Diabetes / All had Renal Impairment / All had cognitive impairment / None of the diagnoses / Mixed health (some had DM and/or renal impairment and/or cog impairment)	Page #: _____ Para #: _____ Figure: _____ Table: _____

	any of the 3 comorbidities:)	**Details** (inc. #, % of sample):	
	Any other pt info:		Page #: _____ Para #: _____ Figure: _____ Table: _____
20. Impact of Covid-19 public health measures?	**Any details recorded:**	☐ Lockdown ☐ Social distancing ☐ Care home visits restricted ☐ Day centre/ community centre closed due to Covid-19 ☐ Study conducted virtually due to Covid-19 ☐ Other:_____ **Details:**	Page #: _____ Para #: _____ Figure: _____ Table: _____

Refer to Appendix 1 in the protocol for definitions of outcome variants.

Outcome	Outcome variant	Details (and description of method/equation used to measure)	Location of support in document *(Page #, Paragraph # on that page, Table or figure)*
Dehydration prevalence	Serum/plasma osmolality data	Units for osmolality: Mean osmolality: Median osmolality:	Page #: _____ Para #: _____ Figure: _____

Study ID:

		Measure of variance (SE / SE / 95% CI / IQ range): Cut-off of osmolality indicating dehydration: Proportion of sample with osmolality above cut-off (indicating dehydration):	Table: _____
	Serum/plasma osmolarity data	Osmolarity equation used: Units for osmolality: Mean osmolarity: Median osmolarity: Measure of variance (SE / SE / 95% CI / IQ range): Cut-off of osmolarity indicating dehydration: Proportion of sample with osmolarity above cut-off (indicating dehydration):	Page #: _____ Para #: _____ Figure: _____ Table: _____
	Saliva osmolality data	Units for osmolality: Mean osmolality: Median osmolality: Measure of variance (SE / SE / 95% CI / IQ range): Cut-off of osmolality indicating dehydration: Proportion of sample with osmolality above cut-off (indicating dehydration):	Page #: _____ Para #: _____ Figure: _____ Table: _____
	BUN: Creatinine data	Mean BUN:Cr ratio value: Median BUN:Cr ratio value: Measure of variance (SE / SE / 95% CI / IQ range): Cut-off of BUN: Cr ratio indicating dehydration: Proportion of sample with BUN: Cr ratio above cut-off (indicating dehydration):	Page #: _____ Para #: _____ Figure: _____ Table: _____
	Fluid intake data	Units for fluid intake: Mean fluid intake: Median fluid intake: Measure of variance (SE / SE / 95% CI / IQ range): Cut-off of fluid intake indicating dehydration: Any guidelines used for cut off?: Proportion of sample with fluid intake above cut-off (indicating dehydration):	Page #: _____ Para #: _____ Figure: _____ Table: _____

Study ID:

Care setting	Community living with no formally identified care needs *(either no care needs or no care reported)*	**Details:** Any support/informal care via family/friends identified?	Page #: _____ Para #: _____ Figure: _____ Table: _____
	Community living with formal/paid care – (Sheltered*/warden-controlled housing or own home with paid care. Includes people who attend day care but reside at home still.)*	**Details:** Care provider/ centre/ setting: What care is provided?: Time duration of care visit(s): Frequency of care visits:	Page #: _____ Para #: _____ Figure: _____ Table: _____
	Hospital for a medical/stabilisation purpose, for acute care, with a planned end date *(Admitted to hospital to receive a medical intervention (e.g fall/ UTI/ psychiatric symptoms) and not for a long term residential purpose)*	**Details:** Admission reason(s): Type of hospital: Type of ward: Median length of stay: Mean length of stay:	Page #: _____ Para #: _____ Figure: _____ Table: _____
	Long term care home/facility *(Long term residence due to extra care needs and support being required.)*	**Details:** ☐ Nurse led model of care (home/facility overseen by a registered nurse) ☐ Social model of care (home/facility overseen by a health professional)	Page #: _____ Para #: _____ Figure: _____ Table: _____

		☐ Physician-led model of care (home/facility overseen by a Dr) ☐ Unclear Type of facility/home (nursing/care home): Size of facility/ home (rooms): Other Details:	
Comorbidity	Renal impairment (usually reported using eGFR)	**Details:** Method of assessment? #/% of sample with renal impairment: Mean eGFR value: Median eGFR value: Measure of variance (SE / SE / 95% CI / IQ range):	Page #: _____ Para #: _____ Figure: _____ Table: _____
	Cognitive impairment	**Details:** Assessment(s) used to diagnose? Mean assessment scores (if provided): Median assessment scores (if provided): Measure of variance (SE / SE / 95% CI / IQ range): #/% of sample with cog impairment: #/% of sample with dementia: Other details:	Page #: _____ Para #: _____ Figure: _____ Table: _____
	Diabetes	**Details:** Diagnosis: Type of diabetes: How is diabetes define by author: #/% of sample with diabetes: Other details:	Page #: _____ Para #: _____ Figure: _____ Table: _____

Staff skill mix of care provision	Personal care worker in health services *(percentage of care staff, which makes up care/nursing team.)*	**<u>Details:</u>** Number of care workers: % of total staff: Qualification level range: Other details:	Page #: _____ Para #: _____ Figure: _____ Table: _____
	Nursing professional *(percentage of nursing staff, which makes up care/nursing team.)*	**<u>Details:</u>** Number of nursing professionals: % of total staff: Qualification level range: Other details:	Page #: _____ Para #: _____ Figure: _____ Table: _____
Care staff to older adult ratio	ratio of care/nursing staff to older adult ratio	Total number of nursing/care staff: Total number of residents: Ratio:	Page #: _____ Para #: _____ Figure: _____ Table: _____
Dependency on others, to meet hydration care needs	*Refer to Appendix 1 for definitions of dependency*	☐ Functionally independent ☐ Semi-independent ☐ Total dependence on others ☐ Mixed dependency level ☐ Unclear dependency level # of sample at each dependency level: % of sample at each dependency level: <u>Please provide any other dependency details below:</u>	Page #: _____ Para #: _____ Figure: _____ Table: _____

Study ID:

Further Information		
	Description as stated in report/paper	**Location of support in document** *(Page #, Paragraph # on that page, Table or figure)*
Key Conclusions of Study Authors		Page #: _____ Para #: _____ Figure: _____ Table: _____
References to other relevant studies		Page #: _____ Para #: _____ Figure: _____ Table: _____
Is Correspondence required for further information? *(What and from whom?)*	1. What Information? 2. Who needs to be contacted?	
Notes:		

Risk of Bias Table

This table will be generated in Covidence, and the relevant types of bias activated within the table, using the JBI critical appraisal checklist (Munn, 2015).

Bias	**Your Judgement of risk (High/Low)**	**Support for judgement, from the document** *(Copy and paste/ type this here in "")*	**Location of support in document** *(Page #, Paragraph # on that page, Table or figure)*
Was the sample frame appropriate to recruit older adults ≥65? *(If more than 10% of the popn were not ≥65, then rate as High risk)*			Page #: _____ Para #: _____ Figure: _____ Table: _____
Were study participants recruited in an appropriate way? *(If 'at risk groups' (cog impairment, renal impairment and diabetes) have been excluded, then rate as High risk)*			Page #: _____ Para #: _____ Figure: _____ Table: _____
Was the sample size adequate? *(If less than 100 pts, rate as High risk)*			Page #: _____ Para #: _____ Figure: _____

			Table: _____
Were the participants and setting described in detail? *(If there is missing information relating to size of care home/facility, support/care provided by the care settings, or details about participants' capacity, then rate as High risk)*			Page #: _____ Para #: _____ Figure: _____ Table: _____
Was data analysis conducted with sufficient coverage of the sample? *(If data analysis excluded data for ≥ 20% of sample, then mark as High risk)*			Page #: _____ Para #: _____ Figure: _____ Table: _____
Was dehydration measured in a standard, reliable way for all participants? *(serum osmolality is low risk, saliva osmolality is low risk, Khajuria and Krahn equation for calculated serum osmolarity is low risk)* *(BUN is high risk).*			Page #: _____ Para #: _____ Figure: _____ Table: _____
Was fluid intake measured in a standard, reliable way for all participants (if measured)? *(If fluid intake is measured by researcher or self-report, then rate as low risk)* *(If fluid intake is recorded by fluid balance charts, or no time frame given for fluid intake, then rate as high risk).*			Page #: _____ Para #: _____ Figure: _____ Table: _____

Was there appropriate statistical analysis ie. did the authors report the number of pts dehydrated and total sample size? *(If sample size and # dehydrated is not fully reported, then rate as High risk)*			Page #: _____ Para #: _____ Figure: _____ Table: _____
Was the response rate adequate, and if not, was the low response rate managed appropriately? *(If there was a response rate of < 60% from total population/ care setting and no justification given for the low response rate, then rate as High risk)*			Page #: _____ Para #: _____ Figure: _____ Table: _____

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