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Dehydration in New Zealand fishing vessel crews

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ABSTRACT

An exploratory investigation of hydration levels of fishers aboard three working fishing vessels in New Zealand waters identified that crew hypo-hydration was common. The opportunity to collect this data occurred in the context of ergonomics work to discover opportunities to reduce musculoskeletal injury rates for fishers. Hydration was considered worthy of inclusion in this exploratory work following anecdotal suggestion that urinary tract and kidney infections were perhaps common in crew. Whilst dehydration-related health problems and detrimental effects on worker performance are well understood, the international literature revealed no previous hydration evaluation specific to fishing crews. Dehydration research has however been reported from forestry, mining and manual labour industries with knowledge that can be applied to the maritime work environment. Hydration (urine specific gravity) was measured with a manual refractometer from crew volunteering to participate, and findings shared with participants. On-vessel crew education regarding hydration practices and factors that may contribute to improved hydration allowed some crew to improve their hydration status, whilst others became more dehydrated during the five week trip. The hypo-hydration finding is concerning as trawler crew work rotating shifts for 7 days per week for periods of up to 6 weeks at sea with potential for dehydration-related health and safety impacts, and productivity loss.

1. Introduction

This exploratory hydration study of fishers working on New Zealand fishing vessels occurred within the context of a broader exploratory investigation of the opportunities to address musculoskeletal injury rates for fishers. A fishing company in 2012 sought ergonomics input to address high musculoskeletal injury rates. More than 50% of recorded crew injuries were identified as 'musculoskeletal', consistent with findings from Maritime New Zealand et al. (2012) and Kahler and Chau (2012) identifying 51% and 58% respectively of similarly defined injuries. New Zealand resources indicated a limited understanding of these fisher injury risks and of targeted interventions to reduce the risks (Edwin, 2013). This specific injury risk has the background of New Zealand fishing and aquaculture having had the highest injury rate of all sectors (Maritime New Zealand et al., 2012; Ministry of Business, Innovation and Employment, 2012; Statistics New Zealand, 2013; 2015), and this is reflected internationally, such as in McGuinness et al. (2013). New Zealand's accident compensation insurer (ACC) funded the musculoskeletal injury exploratory research, and therefore this initial fisher hydration study.

Fishing plays an important role in the New Zealand economy – in 2016 'fish and shellfish' held sixth place in New Zealand's export earnings (Maritime New Zealand, 2017). Fishing is a key employer in the regions with ports, and anecdotal reports suggest difficulty finding suitable crew for the demanding work aboard vessels. Commercial fishing and aquaculture in New Zealand employ around 5700 full time equivalents. Around 18 factory fishing vessels operate in New Zealand, with a larger fleet of smaller (< 24 m) fresher vessels.

Between May and September 2013 several trips on a factory vessel (9 days) and two fresher vessels (3 days) from two different fishing companies occurred. Factory vessels process fresh fish at sea and return with packaged frozen fish ready for market, with trips taking around 6 weeks. Fresher vessels are smaller, returning with chilled whole fish for on-shore processing, with trips taking a few days to 2–3 weeks. The trips occurred over the busy hoki season, gave insight into the nature of work and living activities aboard two different types of fishing vessel, and allowed the researcher to gain a general understanding of the industry. In addition to hydration measures, other data pertinent to musculoskeletal injury risks were gathered. This included a modified Nordic Musculoskeletal Questionnaire, fisher anthropometry, semi-structured interview, task observations, and dimensional assessments of work areas.

Hydration assessment was specifically included as pre-trip anecdotal reports suggested a high frequency of urinary tract and kidney infections among crew. The links between dehydration and performance (including cognitive function, fatigue, work capacity, muscle function and muscle recovery) and long-term health (such as kidney stones) are documented in both the popular and the scientific literature

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(including Bates and Schneider, 2008; Kenefick and Sawka, 2007; and Gopinathan et al., 1988). Importantly for fishing, Bates and Schneider (2008, citing Sawka and Pandolf, 1990) report that in a moderate environment, a 1–2% deficit of body weight (water loss from sweating etc) results in a 6–7% reduction in physical work capacity, and water loss of 3–4% of body weight a reduction of 22% physical work capacity, increasing to a 50% decrement in a hot environment. Given the long work hours and up to 6 week periods at sea this had the potential to represent a significant impact on fisher productivity and health. No (English language) literature on the hydration of fishers was found, so hydration assessment was added to the range of areas explored in this unique on-vessel opportunity. The study sought to determine if dehydration is a potential health risk for New Zealand fishers, and to consider the relationship of hydration to the nature of work and other features of the vessel environment.

2. Method

Urine Specific Gravity was measured with an 'Atago' manual clinical refractometer with a triple scale (for serum protein, refractive index and urine specific gravity) and automatic temperature compensation. Importantly for the vessel environment this hand-held device is robust with results easily viewed through an eyepiece (versus digital). The refractometer's accuracy was calibrated with distilled water prior to the commencement of vessel trips, and it was cleaned under running water and dried between uses with a disposable paper towel. The ergonomist wore latex gloves and corrective lenses (rather than safety glasses) to enable safe task completion.

Participants were volunteers from most job types on all the vessels. Urine samples were collected from crew members in clean (but not sterile) plastic cups. No effort was made to ensure that samples were not tampered with via direct observation or removal of water sources that could be used to alter the sample (as is standard procedure in AS/NZS 4308: 2008 'Procedures for specimen collection and the detection and quantitation of drugs of abuse in urine'). Given some crew having concerns about whether this was drug testing of urine 'in disguise', those providing the sample were responsible for tipping the remaining urine down the toilet at completion of the test – thus ensuring a trust relationship. The toilet area used for most sample collection on the factory vessel was a unisex facility. Crew members gave their fresh urine sample directly to the ergonomist and a cotton bud was used to transfer a few drops to the refractometer window. The refractometer was held to the light to view the urine specific gravity reading, and the result recorded along with the time of day and crew member identification. Crew were invited to view their results through the refractometer.

Voluntary hydration testing of urine occurred at three times. *Initial urine testing* was carried out within the first few days of ergonomist time on the 3 different vessels, at any convenient time in the day. As some crew of the factory vessel were keen to determine if they were able to improve their hydration status, some *follow-up urine tests* occurred within several days of the initial, before the ergonomist disembarked. Further *trip-end urine testing* was completed with crew from the factory vessel when the vessel returned to port some 4 weeks following the initial and follow-up tests. Crew were not informed that this trip-end testing would occur, so they did not have a prompt to alter their fluid intake. Some of these trip-end urine tests were re-tests/follow-up, but 7 were first time tests and therefore categorised as initial tests.

There was limited space and generally crowded conditions around shift changes and at break times for the small toilet and change areas that were available to carry out this activity. Thus, there was little opportunity to control proximity to other crew members and therefore privacy of results. Whilst many were happy to publically share and compare their results, it was clearly uncomfortable for some crew members. Many of those appearing uncomfortable were approached individually to arrange a time to meet the ergonomist where privacy was more likely. Some crew did not volunteer to participate, and some required reassurance that no other information could be gleaned from this test – e.g. pregnancy, infections or sexually transmitted diseases.

The informal nature of the urine collection environment in combination with crew interest in the topic resulted in many educational discussions on the effects of hydration on performance and health, which acted to reinforce the relevance of these findings to fishers.

3. Results

3.1. Fisher hydration

A total of 49 fishers participated in initial urine testing (39 male, 10 female) at the start of a vessel trip. Crew members tested included skippers and first/second mates, deck hands, and factory and freezer staff. Groups that chose not to participate were engineering staff, meal plant operators, cooks and the vessel observer. Participants included 37 of the crew of 45 from the factory trawler, 9 of a crew of 17 from a large fresher (whole fish) vessel, and 3 of a crew of 5 from a small fresher vessel. Thus, initial urine testing data was captured from 73% of all crew aboard the 3 vessels.

Initial urine testing revealed that only a small number of crew were well hydrated (euhydrated) or slightly under-hydrated (hypo-hydrated) and that a high number were dehydrated (Table 1). The hydration ranges used reflect consideration of the literature and fit largely with the interpretation table from Bates and Schneider (2008), but for simplicity combining 'moderately dehydrated' (1.020–1.025) and 'dehydrated' (1.025–1.030) into the one 'dehydrated' category, as in Table 1.

Further, 16.3% (8) of the initial urine tests indicated that fishers were clinically dehydrated, with USG of > 1.030. Clinical dehydration suggests higher risk of physical and cognitive performance decrements and longer-term health risks such as kidney stones.

Follow up (on-vessel) urine testing was completed for some fishers interested in improving their hydration status. Most of these individuals improved their hydration status, but some became more dehydrated – despite their desire to improve their hydration. Additional trip-end urine testing was carried out with the trawler crew on their return to port, some 4 weeks after the original testing. Of these 24 trip-end retests, 54% had better levels of hydration, 42% were more dehydrated, and one fisher's hydration level had not changed. Both sets of follow up test results are given in Table 2.

Comments suggested that those with better levels of hydration at trip end had consciously worked to improve their hydration following the on-vessel focus on this topic and new learning. With the small sample the consideration of sex differences (5 females and 19 males for trip-end retesting) may be misleading. Both male and female cohorts had individuals who improved their hydration during the trip, and some who became more dehydrated.

For those who were clinically dehydrated at start of trip (USG > 1.030) and who were retested at trip end (n = 5), 3 improved their hydration levels by 1 category (to 'dehydrated') and 2 improved their hydration levels by 2 categories (to 'hypo-hydrated'). This suggests that knowledge of more extreme dehydration in combination with education to improve hydration may result in crew gaining better hydration levels.

The literature on hydration within various industry groups provides

Table 1
Initial urine testing hydration results from fresher/factory vessel crews (n = 49).

Hydration status	Urine specific gravity	Percentage
Euhydrated	USG 1.0003–1.015	8.2% (4)
Hypo-hydrated	USG > 1.015–1.020	8.2% (4)
Dehydrated	USG > 1.020	83.6% (41)

Table 2
On-vessel and trip-end hydration retests.

	Hydration improved	Hydration remained same	Became more dehydrated
On-vessel retests (n = 10)	8 (80%)	0	2 (20%)
Trip-end retests (n = 24)	13 (54%)	1 (4%)	10 (42%)

Table 3
Hydration status in industry groups.

Industry group studied	Dehydration with USG/colour measure	Mean hydration with USG measure
NZ fishers (2013)	83.6% dehydrated (USG > 1.020),	USG 1.025
NZ loggers (Parker et al., 2001)	80.6% dehydrated (USG > 1.020)	
South African forest workers (Biggs et al., 2011)	Post shift dehydration (USG > 1.020) 64% autumn, 63% winter	
Australian surface/underground miners (Hunt et al., 2013)	71% minimally or significantly dehydrated per urine colour	
Australian underground miners (Polkinghorne et al., 2013)	58% dehydrated (USG > 1.020)	
Australian miners/processers (Peiffer and Abbiss, 2013)		USG 1.029 for miners, USG 1.021 for processers.
Australian fly-in/fly-out minerals workers (Carter and Muller, 2007)		USG 1.022

comparative data sets and knowledge of alternative methodologies that will inform those interested in fisher hydration. Some key findings are summarised in Table 3 alongside results of this study's hydration data. This exploratory study's results suggest that NZ fishers are one of the most dehydrated work groups studied.

3.2. *Factors impacting on fisher hydration*

On-vessel discussions and observations yielded valuable knowledge of associated factors that create an environment for hypo-hydration.

3.2.1. *Seasickness and ocean environment*

Some fishers reported an ongoing struggle with seasickness, making it difficult to sustain good nutrition and hydration for the full trip. Fishers susceptible to vomiting when seasick will have fluid loss and be more at risk of dehydration impacting on both their health and their work performance. In this exploratory study there was no clear link between the general information gathered regarding seasickness and the fishers who were dehydrated. Several fishers also wondered on the psychological impact of being surrounded by the 'apparently wet' ocean, that perhaps has the effect of making them feel cool and hydrated, even if they are not. Whilst such a phenomenon was not found in the literature, it is a plausible factor that should be acknowledged for fishers.

3.2.2. *Trip length and frequency*

The potential health risks from dehydration are increased as many fishers work 6 week trips on either a 'trip on – trip off' or 'two trips on, one trip off' basis, working 7 days per week. This gives the potential for long periods of exposure to the vessel environment with apparently high dehydration risks and without recovery time.

3.2.3. *Toilet facilities*

A key contributor to dehydration for one vessel was that the mixed male and female crew had shared access to just one primary toilet nearest the factory. For men with the cultural practise of urinating in standing, urinating aboard a moving vessel has the frequent result of urine spray around the toilet bowl and floor. Women using the same facility then contend with the need to clean up before sitting to urinate. Many female crew members consequently avoided use of this toilet – reportedly by limiting their fluid intake so that they only needed to use the toilet in their own cabins, between 6 h shifts (rosters were 6 h on, 6 h off). The impact of toilet access impacting on women's hydration status was similarly noted by Kenefick and Sawka (2007). When this observation was made and discussed with the vessel management team and crew, a solution was quickly identified – men were required to access a second toilet a little further from the factory.

Anecdotally, female fishers reported that they would often experience urinary tract infections, with a number indicating that they always bought medical supplies with them to self-treat for these conditions. The shore-based occupational health nurse for the fishing fleet was unable to confirm the claim that such conditions are common, suggesting that either the anecdotal reports are misleading, or that these conditions simply remain unreported. This suggests that for female fishers particularly, attention to hydration may also result in improved general health.

3.2.4. *Cabin heating*

Another factor appearing to impact on crew hydration is that cabins are closed rooms that are heated and ventilated via the vessel's internal system. This appeared to create a sleeping environment that some fishers found too hot and uncomfortable. Environmental data was not gathered during this assessment, but some fishers reported that they often woke feeling very "thirsty and dry" suggesting the importance of monitoring the cabin environment and ventilation system to ensure it supports good health.

3.2.5. *Water quality and availability*

An historic issue of vessel water quality appeared to impact on some fisher's hydration habits. Older fishers familiar with small inshore vessels with water supplies that taste notoriously poor reported that they had 'learned not to drink water' when aboard. Vessel water tanks were commonly rust, or fuel tainted – causing the water to be unpleasant and sometimes undrinkable. They would only drink coffee or other flavoured drinks or use bottled water bought on to the vessel. This is echoed by Carter and Muller (2007) who found that for Australian fly in/fly out mineral extraction and processing workers the perceived taste of water appeared to influence hydration behaviour. This taste aspect seemed to be linked closely with the intake of caffeine – to both disguise the water flavour and to manage the demanding work hours. For some individuals this extended to bringing on board cases of highly caffeinated and sugar-loaded energy drinks. The impact of consumption of such beverages by crew warrants further consideration.

Access to drinking water whilst working was also impacted by the nature of the vessel environment – water bottles were considered by crew as 'not allowed' in the factory for food hygiene reasons (with some lack of clarity on this from vessel management), there were few drinking fountains, and there was little storage for any personal items including water bottles near to work areas. Some crew reported accessing drinking water from the eye-wash facilities as these were available in the factory. Most fluid was consumed in the dining area, where hot and cold drinks and filtered water were readily available. Water consumption during shifts could be encouraged with better water supplies nearer to the factory and other work areas, including drinking cups large enough for a 'good drink'. Some fishers were critical of the small cups often provided.

As many vessels provide drinking water via desalination plants (in addition to tanks of water piped on when in port) the impact of drinking desalinated water over long periods at sea should be considered. Health concerns in desalination focus on ensuring that pathogens and chemical contaminants are removed and addressing water quality to reduce its corrosiveness and provide remineralisation (WHO, 2011). It is recommended that desalinated water should be rebalanced to contain: a minimum level for dissolved salts, bicarbonate ions, and calcium; an optimum level for total dissolved salts; and a maximum level for alkalinity, sodium, boron and bromine (WHO, 2005). WHO outlines the possible adverse effects of consuming water with low mineral content – increased urine output, body water volume and serum sodium concentrations; decreased serum potassium concentration; and increased elimination of sodium, potassium, chloride, calcium and magnesium ions from the body. An adequate intake of electrolytes must therefore be ensured to prevent dilution of the electrolytes dissolved in the body. Symptoms related to electrolyte dilution might initially include tiredness, weakness and headache, or become more severe and lead to muscular cramps and impaired heart rate. Further, a lack of calcium and/or magnesium in drinking water is associated with cardiovascular disorders, tiredness, weakness and muscular cramps.

Therefore, if seeking a robust understanding of the issues around hydration for fishers that commonly consume desalinated water, this topic should be investigated further. It appears that fishers should be provided with information on replacing electrolytes as an important part of rehydration, particularly for those carrying out work that makes them sweat profusely.

3.2.6. Self-care aspects

The various 6, 8 and 12 h shift schedules impact on the frequency of showering needed to maintain personal comfort and hygiene. For the 6 and 8 h shifts this creates pressure on time for self-care – showering, sleeping, eating and socialising. Discussion with fishers suggested that consequently they did not have the time or energy to always attend to good eating and drinking regimes.

In addition, workers engaged in active duties (such as stacking crates in the chilled holds of fresher vessels) reported that they did not like to sweat whilst working as it created more personal laundry and became uncomfortable – "you sweat and then get cold when you stop moving" or unhygienic – "sweating over the catch". This was exacerbated by the wearing of non-breathable waterproof clothing such as bibbed overalls. These factors caused some fishers to reduce their fluid intake and suggest the opportunity to consider clothing that is more suited to specific work activities.

3.2.7. Fatigue

Associated with the demanding shift schedules – particularly the '6 h on, 6 h off' roster - was the tendency for overall fatigue levels to increase as the trip continues. Whilst not formally measured during this study many fishers discussed that they became increasingly 'tired' as the trip progressed. The inter-relationship of both physical (endurance and work capacity etc.) and cognitive fatigue elements with dehydration should be considered. Dehydration may contribute to performance decline and may be a result of performance decline – failure to remember to maintain hydration.

3.2.8. Nature of work

Fishers participate in a variety of work activities with a wide range of task demands. This includes: preparing the vessel for the trip by bringing supplies on board and stowing them, deck work, moving fish out of the pounds (fish holding areas) and onto factory conveyors, loading head/tail machines, working at trimming conveyors, quality control tasks, work in weighing and packing areas, manual filleting, cleaning and maintenance activities, packing boxed product into outers and storing them in the freezer hold, staff training and management activities, and work on the bridge.

Factory crew carry out a range of sorting, filleting, trimming, machine operation, quality checking and packing activities – so some tasks are lighter and static, others demand intermittent lifting and handling of up to 25 kg trays of product or hand-filleting of heavy by-catch species. On factory vessels the freezer staff carry out consistent manual handling of approximately 25 kg boxed product whilst in the freezers, so in a cold work environment. Meal plant operators may work in the hot meal plant environment and frequently handle 30 kg bags of product.

Deck work can be heavy and physical and is outdoors in all weathers. On factory vessels while the vessel is trawling 'deckies' move into the factory to assist with packing and other lighter duties, with intermittent handling of up to 25 kg loads. On fresher vessels 'deckies' work in the hold to fill crates with fish and ice, working fast and consistently to stow the catch before the next trawl is bought up. This work may be strenuous and 'sweaty' and crew from these areas were generally more aware of the need to stay hydrated.

Deck and factory crew on trawlers work shifts that are 6 h on/6 h off for 7 days per week whilst at sea for up to 6 weeks, whilst fresher crew generally worked 8 h on/8 h off for 2–3 week trips. Roster arrangements were less structured for small fresher vessels on 2–3 day trips.

3.2.9. Fisher education

Fisher training and the vessel work culture did not include knowledge of hydration as a means of keeping fit for work, despite the very challenging work environment and demanding task nature. Thus, most crew had no notion of hydration as an element of self-care and a 'health and safety' focus. The notable exception was the few crew members that when on-shore were keen sports people. Some of these individuals had an effective knowledge of hydration and an approach to nutrition and fitness that gave them better capacity to cope with the demanding work environment and tasks.

4. Discussion

The hydration results suggest that dehydration is both common and at concerning levels among fishers crewing commercial trawlers in New Zealand. This raises some concerns for fisher health and productivity:

a. Dehydration contributes to physiological fatigue and muscle function, suggesting that the high musculoskeletal injury rates of fishers may be linked to this dehydration finding.
b. Dehydration has known impacts on physical endurance and work performance and may be reducing overall fisher productivity.
c. The known impacts of dehydration on cognitive function including alertness, decision-making, short term memory, and attention may be linked to work-related accidents.
d. Long-term dehydration is linked with cardiovascular health issues and kidney conditions, suggesting that fishers may be exposed to longer term health risks associated with dehydration.

The Parker et al. (2001) study of New Zealand loggers found that most (93.5%) loggers were hypo-hydrated (USG > 1.016) and 80.6% were dehydrated (USG > 1.020). Consideration of this finding alongside New Zealand fishers' hydration levels may suggest that New Zealand conditions, cultures and practices in some way support hypo-hydration as a norm. Bates et al. (2001) and Parker et al. (2002) have further discussion on the type of fluid and fluid intakes of the New

Zealand logger population which may have relevance to New Zealand fishers. Further, the notion of involuntary dehydration is discussed by Arnaoutis et al. (2013) with questioning of the current hydration cut-off points in common use. Further, the study by Polkinghorne et al. (2013) on the hydration of underground miners noted that miners with USG results indicating dehydration were more likely to be obese. They discussed the need to link education on healthy lifestyles, body weights and hydration for this group. Any further hydration studies with New Zealand fishers (or other New Zealand worker populations) should consider these aspects.

In addition, dehydration is often associated with hot or humid work environments and is a component of heat-related illnesses. Whilst thermal environment was not specifically investigated in this exploratory study, dehydration may be a specific concern for crew in some vessel work areas; such as engineers working in hot engine rooms or operators of fish meal plants – often a hot work environment. This suggests that close attention to hydration may be specifically indicated for some vessel job types with higher dehydration risks. The work of Bates and Schneider (2008) with United Arab Emirates construction workers suggests some guidance for workers exposed to heat – recommending that a 'start of shift' USG of below 1.020 is desirable. Further work with fishers may determine hydration level recommendations for start of trip and start of shift that give more specific health guidance for fishers.

This work included a range of limitations that should be acknowledged. These were: that the environment that samples were given in was not controlled, creating the possibility that samples were contaminated; that open discussion of hydration issues occurred for some people prior to testing, meaning that hydration behaviours may have altered before testing; and that other factors linked with hydration (such as heart rate and workload) were not formally measured. Literature review and these assessment findings suggest that further fisher hydration research could include: hydration measures using a refractometer, triangulation with body weight before/after shift, clothing ensembles, fluid type/quality, tracking of fluid consumption, general health and wellbeing (including seasickness), body weights, off-trip hydration measures to determine if fishers are always hypo-hydrated, heart rate/workload monitoring, aural temperature, perceived water taste, environmental measures (such as WBGT and TWL), access to fluids, and water quality on vessel.

Despite these limitations, this study has an important strength – data was gathered directly from fishers whilst working at sea – a unique work environment that is both difficult to access and physically challenging to carry out research in. Further, the researcher's time at sea as participant-observer developed familiarity with the people and environment, resulting in a stronger instinct for intervention and implementation design that will work in this environment.

Whilst on-vessel it became apparent that the close living/working environment provided many opportunities for the provision of fisher education and training (particularly on the factory vessel). Whilst an atypical training environment, it was possible to have discussions with all crew levels/types – skipper, first mate, factory manager, factory workers, deck hands, cook and galley hand, medic, and engineers/technicians – with relative ease. Respect for the importance of crew sleep was critical due to the 6, 8 or 12 h shift schedules – and a flexible approach to training provision was necessary. Much was via informal discussion – perhaps over a meal, in passing in a passageway, or at a coffee break. However, fishers were generally receptive to new learning that might assist them to both feel better and work more effectively.

Training accomplished whilst on-vessel pertained both to hydration and musculoskeletal injury prevention generally. Training topics included: stretching and fitness, safer work methods, lifting and handling techniques, discomfort and injury management advice, optimal hydration/nutrition, and break practices for injury prevention. Training was able to be provided in the tea-break areas, in the mess, or on the bridge. Training was formalised in consultation with the skipper and management team and able to be done both in small groups, or one-to-one. Shy crew members were comfortable asking questions of the researcher as their comfort levels with her presence gradually increased – particularly when on-vessel for over a week. This allowed health and wellbeing concerns to be shared, some for the first time.

The topic of hydration proved to be of high interest, particularly as many fishers were returning hypo-hydrated results on testing. The researcher's presence on-vessel made it possible to provide feedback through repeated hydration assessment, and the opportunity to have ongoing discussions with crew members about hydration. Some crew altered their hydration practises accordingly. Fishers appeared grateful for the attention of an 'expert' on-vessel, as their training is usually restricted to standard on-vessel topics, and brief training that occurs in the very busy time ashore at vessel-turnaround. Given high fatigue levels the ability to gradually introduce new learning, and to clarify and reinforce key messages over several days appeared beneficial. In addition, the industry credibility of the researcher was heightened by spending time on-vessel with a willingness to share knowledge and engage in discussion.

The wide range of fisher task demands suggests the need for targeted and explicit education – those in roles with more cardiovascular demand ('sweaty work') will require workers to have excellent knowledge of hydration including the need to replace fluids, electrolytes and carbohydrates appropriate to the work demands. For those in more static work roles (such as trimming and quality roles) only general hydration knowledge is required. These specific hydration knowledge packages should be provided alongside those topics specific to musculoskeletal injury prevention. Further to this study, some fishing-specific education material including information on hydration was created for ACC's 'WorkSmart Tips' resource package (http://worksmarttips.co.nz/) available online from mid-2014.

Along with appropriate training for fishers, fishing operators should also address the work environment, and vessel and job design to ensure that good hydration is supported. This may include male and female toilet provision near to work areas; the provision of quality drinking water and when indicated electrolyte/carbohydrate drinks; the provision of drinking vessels that encourage appropriate fluid intake; shift length and recovery time; and jobs designed to be sustainable without a negative impact on health over the given work periods. This may include the investigation of automation for the heaviest and most repetitious job types. These are discussed further in Edwin and Guard (2014).

5. Conclusion

This exploratory study investigating the hydration of fishers from three working New Zealand fishing vessels found that hypo-hydration is common, suggesting that it is a potential health risk for fishers. Dehydration was at a level likely to be impacting on: fisher fatigue and muscle function, potentially contributing to high musculoskeletal injury rates; endurance and work performance, possibly impacting on overall productivity; cognitive decrements that may be linked with work-related accidents; and long-term dehydration that is linked with cardiovascular and other health conditions. Fishers and fishing companies had little awareness of the relevance of hydration for worker health and safety, or for productivity. Aspects of fisher's work and the vessel environment that may contribute to dehydration includes seasickness, trip length, toilet facilities, cabin heating, water quality and availability, time available for self-care activities, work clothing, the nature of work activities, and fisher knowledge regarding hydration and fatigue. For fishers, dehydration may both contribute to, and be a result of, performance decline. Fishing companies should ensure that their crews understand the importance of maintaining hydration; provide appropriate toilet facilities; and ensure that appropriate drinking facilities and good quality drinking water are provided. Other aspects of the work environment and job design may also support improved fisher hydration, including shift length and recovery time, and jobs that are sustainable without negative health impacts.

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