

Household water insecurity, depression and quality of life among postnatal women living in urban Nepal

Yoko Aihara, Salina Shrestha and Jyoti Sharma

ABSTRACT

Objectives: This observational study aimed to assess distress related to the household water supply and to examine the relationship between household water insecurity and psychological health among Nepali postnatal women. **Methods:** In total, 300 women consented to participate in the study, of which 267 women were able to participate in a follow-up 1 month after discharge. We developed a household water insecurity scale (HWIS; total score range 0–24 points) by adapting the household food insecurity access scale. **Results:** The Cronbach's coefficient alpha for the HWIS was moderately acceptable. Psychological health was assessed in terms of postnatal depression and physical health-related quality of life (HRQOL). The median score of the HWIS was 8, and more than 60% of the participants answered that they sometimes or often worried about not having enough water, used only small amounts of water, had a lack of hygiene, and had insufficient time for childrearing. Multiple regression models showed that women with high levels of stress derived from household water insecurity had greater odds of probable depression and lower physical HRQOL scores than did women with low HWIS scores. **Conclusion:** The results suggest that improving water security is necessary to foster maternal psychological health in developing countries.

Key words | Nepal, postnatal depression, quality of life, urban water insecurity

Yoko Aihara (corresponding author)
Kobe City College of Nursing,
3-4 Gakuennishimachi Nishi-ku Kobe-city,
Hyogo 651-2103,
Japan
E-mail: yanzu99@gmail.com

Salina Shrestha
Interdisciplinary Graduate School of Medicine and
Engineering,
University of Yamanashi,
4-3-11 Takeda,
Kofu-city,
Yamanashi 400-8511,
Japan

Jyoti Sharma
Department of Gynaecology/Obstetric,
Institute of Medicine,
Tribhuvan University,
Maharajgunj 3,
Kathmandu,
Nepal

INTRODUCTION

Due to the high demand for water to supply agricultural and industrial activities and to sustain urban populations, water scarcity has occurred in many parts of the world. A recent study has reported that in 201 river basins with over 2.67 billion (10^9) inhabitants, severe water scarcity has occurred at least 1 month out of the year (Hoekstra *et al.* 2012). In addition, more than half of the population living in less developed countries do not obtain their water from pipes on their premises (World Health Organization & United Nations Children's Fund Joint Monitoring Programme for Water Supply & Sanitation (JMP) 2014). In urban areas, the coverage of connected water sources is higher than in rural areas. However, due to rapid population growth, economic development, and changes in consumer behaviour, water insecurity is a growing concern in many urban areas (McDonald *et al.* 2011; Qi & Chang 2011).

Water insecurity, defined as insufficient or uncertain access to safe water for an active and healthy lifestyle (Hadley & Wutich 2009), has adverse health effects. For example, excessive time spent fetching water is associated with an increased prevalence of diarrhoea among children in developing countries (Pickering & Davis 2012). Water insecurity not only influences physical health, but also emotional well-being. Insecure access to food has been found to be a major source of anxiety, distress, and lower quality of life (QOL; Stuff *et al.* 2004; Casey *et al.* 2005; Weaver & Hadley 2009; Sharkey *et al.* 2011). Water is similar to food in that it fulfils a basic human need, thus, water insecurity similarly affects psychological health and QOL. Moreover, in water-poor areas, residents sacrifice a large portion of their time to collecting water and thus have less time for social activities; this time-cost burden further

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decreases well-being. A study on urban squatters in Bolivia found that constantly engaging in negotiations and arguments about the right to water was related to emotional distress. This result suggests that water-related psychological distress develops in the absence of clear procedures or established water rights (Wutich & Ragsdale 2008).

Women and young girls are known to be particularly vulnerable to water insecurity (Blackden & Wodon 2006; Cameron *et al.* 2011). Women play a central role in managing and safeguarding household water in many developing countries (Ray 2007). Moreover, women tend to be responsible for the entire family's health. Therefore, they feel more pressure to provide safe drinking water and hygiene. For women, the postnatal period is a time of increased vulnerability to affective disorders (Ross & McLean 2006). In addition, the impact of water insecurity on postnatal women's health is also harmful to their newborn's health. The global health impacts of water insecurity on women's psychological health and well-being are extensive; however, to our knowledge, most prior studies have looked at the impacts of food insecurity on women's psychological health and well-being, while fewer studies have examined the association between water insecurity, psychological health, and QOL alone. Therefore, the aims of the current observational study were to assess distress related to the household water supply, and to examine the association between water insecurity and postnatal depression and physical health-related QOL (HRQOL) among postnatal women living in urban Nepal.

METHODS

Study setting

The study was conducted in the Kathmandu Valley, Nepal, where water insecurity is a chronic problem. The annual population growth rate in the valley is 4%, while for the whole of Nepal is only 1.4%; furthermore, it is one of the fastest growing metropolitan areas in South Asia (Central Bureau of Statistics Government of Nepal 2012; World Bank 2013). In 2010, water coverage was estimated to be around 79% for the population in the valley. However, rapid urban population growth has triggered increases in

the demand for water supply. The estimated demand for daily water supply in this region is 195 million litres, whereas the supply level is only around 140 and 100 million litres during the wet and the dry seasons, respectively (Asian Development Bank 2010).

Study participants and sample size

Study participants were recruited among postnatal women who had been admitted for delivery to the obstetric wards of the governmental tertiary hospital between February and April (i.e. the dry season) 2013. The inclusion criterion for the study was having a singleton birth. In low- and lower-middle income countries, the weighted mean prevalence of postnatal depression in tertiary hospitals was found to be approximately 14% (Fisher *et al.* 2012). The sample size was set at 186 postnatal women for a 5% level of significance and 5% precision rate. Local clinical nurses conveniently selected women and explained the study protocol to them after delivery, resulting in a total of 300 postnatal women who agreed to participate in the study. Trained health professionals obtained baseline information through a structured questionnaire administered via a face-to-face interview.

All the participating women were invited for a postnatal follow-up examination 1 month after discharge. They were reimbursed the transportation fee from their house to the clinic. A trained interviewer conducted face-to-face interviews for participants who visited the clinic; for women who did not visit the clinic, interviews were conducted via telephone. Consequently, 267 women were interviewed during follow-up.

Measurements

In the baseline survey, women were asked about sociodemographic characteristics (age, living area, family size, caste, educational background, and household income), parturition characteristics (delivery type, birth experience, and infant's sex and birth weight), and household water supply (connected water and water supply hours).

In the follow-up survey, a structured questionnaire was administered comprising measures of physical symptoms of women and babies, mental health, physical HRQOL,

and social support, as well as the household water insecurity scale (HWIS). The Edinburgh Postnatal Depression Scale (EPDS) was used to assess mental health among the participants. The cut-off point was 12/13 based on a previous study in Nepal (Regmi *et al.* 2002). Physical HRQOL was assessed with the WHOQOL-BREF (World Health Organization 1996). The WHOQOL-BREF comprises 26 items that measure physical health, psychological health, social relations, and the environmental aspects of QOL. Among these domains, we used only the seven questions related to physical health. Subjective social support was measured using the Duke Social Support Index which comprises 11 items related to size of social network and perception of and satisfaction with social support (Koenig *et al.* 1993). This instrument assesses the essential components of social support related to mental health outcomes (Gao *et al.* 2009).

To our knowledge, there is currently no validated measurement scale for household water insecurity. Thus, we developed the HWIS by adapting the household food insecurity access scale (Swindale & Bilinsky 2006). The HWIS consists of six items measuring three domains including 'anxiety and uncertainty about household water access', 'insufficient quantity and quality of water', and 'insufficient water intake and its health/behaviour consequences'. Each item asked the frequency that a household engaged in a certain behaviour or experienced a certain situation in the past 30 days. The questionnaire offers five possible answers for each item (never = 0, rarely = 1, sometimes = 2, often = 3, or always = 4), and the total score is calculated as the sum of the six item scores (0–24). The internal consistency reliability of the HWIS was moderately acceptable (Cronbach's coefficient alpha = 0.73).

Ethical issues

All participants provided written informed consent. Ethical approval for this study protocol was granted by the Institutional Review Board of the Institute of Medicine at the Tribhuvan University, Nepal (approval date January 31, 2013) and the Ethical Committee of the Faculty of Medicine at the University of Yamanashi, Japan (protocol number 1011, approved data on December 12, 2012). Women with EPDS scores >12 were provided with counselling sessions by a clinical obstetrician or nurse.

Statistical analyses

The outcome variables comprised probable depression and physical HRQOL, and the primary explanatory variable of interest was the HWIS. Descriptive statistics were used to assess women's characteristics and HWIS scores. HWIS scores did not follow a normal distribution. Thus, Spearman's rank correlation coefficient was used to examine the relation between HWIS score and the two outcome measures. Subsequently, multiple logistic regression was used to identify the association between HWIS score and postnatal depression, while multiple linear regression was used for the association between HWIS score and physical HRQOL. All regression analyses controlled for potential confounding factors including sociodemographic and par-turition characteristics, water supply levels, and social support. All statistical analyses were performed using STATA 12.0 (Stata Corp., USA) and the statistical significance level was set at $P < 0.05$.

RESULTS

The mean (standard deviation) age of the 267 participants was 26 (4) years. Although 92.9% of the participants' households were connected to a water pipe or had wells on the premises, only 15% of households were supplied with piped water continuously. In addition, the median (interquartile range) of hours of weekly piped water supply was 4 (2–20). At the 1-month follow-up after discharge, 17 women (6.4%) met the threshold for probable postnatal depression. The mean (standard deviation) of physical HRQOL was 24.5 (1.8). The characteristics of the participants are shown in Table 1.

The percentages for the HWIS items are shown in Table 2. The median (minimum–maximum) of the HWIS score was 8 (0–16). Almost 70% of the participants sometimes or often worried about not having sufficient water, and 66% of the participants reported using less water because of a lack of resources. In addition, 60% of the women sometimes felt that they could not devote enough time to child-rearing due to an insufficient water supply. In contrast, more than 90% of the participants had never experienced poor quality of drinking water, and none of

Table 1 | Characteristics of the participants

Variables		<i>n</i> = 267 (%)
Water connection at home	No water on premises	19 (7.1)
	Connected piped water	116 (43.5)
	Having well	46 (17.2)
	Piped water and well	86 (32.2)
Duration of piped water supply (hours per week)	≤4 hours	95 (35.6)
	>4 hours	49 (18.4)
	Continuous supply	40 (15.0)
	Do not know	17 (6.4)
	No connected water	66 (24.7)
Postnatal depression	Presence	17 (6.4)
	None	250 (93.6)
Physical HRQOL	(mean ± SD)	24.5 ± 1.8
Age in years	(mean ± SD)	25.8 ± 3.9
Family size (persons)	(mean ± SD)	4.8 ± 2.1
Caste	Bramhan	109 (40.8)
	Chettri	54 (20.2)
	Newar	36 (13.5)
	Janajati	62 (23.2)
	Dalit/Other	6 (2.5)
Educational background	No literacy/No formal education	13 (4.9)
	Primary school (1–5 years)	9 (3.4)
	Lower secondary school (6–9 years)	29 (10.9)
	Upper secondary school (10–12 years)	102 (38.2)
	College/University	113 (42.3)
Household income	No fixed income	31 (11.6)
	<NRs. 10,000	44 (16.5)
	NRs. 10,000–19,999	70 (26.2)
	≥NRs. 20,000	69 (25.8)
	Do not know/Do not want to disclose	53 (19.9)
Delivery type	Vaginal	134 (53.6)
	Caesarean	116 (46.4)
Birth experience	Premiparae	166 (62.2)
	Multiparae	101 (37.8)
Physical symptoms or sickness	Have	33 (12.4)
	None	234 (87.6)
Sickness of baby	Presence	51 (19.1)
	None	216 (80.9)
Social support index	(mean ± SD)	19.3 ± 2.0

QOL: quality of life, SD: standard deviation.

NRs 1 = USD 0.011.

their family members had fallen ill from drinking water. The Spearman's correlation coefficients between the HWIS score and the EPDS and physical HRQOL scores were -0.18 ($P = 0.003$) and 0.16 ($P = 0.008$), respectively.

Table 3 shows the associations of HWIS score with probable postnatal depression and physical HRQOL.

Multiple logistic regression showed that the postnatal women with higher HWIS scores had a greater odds of having probable depression compared with the women with lower HWIS scores (odds ratio = 1.43, 95% confidence interval = 1.01–2.02). Multiple linear regression showed that higher HWIS scores were related to lower physical HRQOL

Table 2 | Frequency and proportion of each item of HWIS among postnatal women (*n* = 267)

Questions	Answer	<i>n</i> (%)
How often did you worry that your household would not have enough water?	Never	35 (13.1)
	Rarely	46 (17.2)
	Sometimes	137 (51.3)
	Often	49 (18.4)
How often did you or your household members use just a little water day after day because of a lack of resources?	Never	38 (14.3)
	Rarely	53 (19.9)
	Sometimes	173 (65.0)
	Often	2 (0.8)
How often were you or your household members not able to maintain good hygiene because of a lack of resources?	Never	37 (13.9)
	Rarely	50 (18.7)
	Sometimes	175 (65.5)
	Often	5 (1.9)
How often did you or your household members drink poor quality water because of a lack of resources to obtain other types of water sources?	Never	241 (90.3)
	Rarely	14 (5.2)
	Sometimes	11 (4.1)
	Often	1 (0.4)
How often did you or your household members become sick because of a lack of clean water supply?	Never	247 (92.5)
	Rarely	9 (3.4)
	Sometimes	11 (4.1)
	Often	0 (0.0)
How often did you feel that you were not able to carry out sufficient child-rearing because of a lack of supply water?	Never	69 (25.8)
	Rarely	36 (13.5)
	Sometimes	161 (60.3)
	Often	1 (0.4)

Mean (median, minimum–maximum) of total HWIS = 6.4 (8, 0–16).

scores (regression coefficient = -0.11 , $P = 0.01$). On the other hand, no statistically significant associations were observed between household piped water supply and psychological health status among the participants.

DISCUSSION

Because there is a vital need for water, people living in areas with water scarcity may suffer from high physiological and psychological distress. The present study adds to the literature by suggesting that higher household water insecurity is associated with probable depression and low physical HRQOL among postnatal women living in urban Nepal.

Although approximately 93% of the participants' houses had piped water or a well, only 15% of the participants stated that the piped water was continuously supplied. Furthermore, more than 60% of the participants complained that they sometimes or often worried about a lack of water

and used less water than they needed. Several studies have reported that higher household food insecurity is associated with poor mental health and well-being among women (Sharkey *et al.* 2011; Dewing *et al.* 2013; Clarke *et al.* 2014). Stress or anxiety from insufficient food resources and uncertain access to adequate foods may have adverse psychological health effect (Stuff *et al.* 2004). Similar to household food insecurity, an insufficient water supply and uncertain access to safe water may lead to poor psychological health among the participants. Due to a poor water supply level, most of the participants collected water from other water sources, including vendors, tankers, and the public well. In less developed countries, women experience more stress related to water scarcity than men do because of their greater responsibilities, such as walking and waiting to collect water from public water sources or searching for a water vendor (Wutich 2009). In addition, around 60% of the participants stated that they did not have sufficient time for childcare, which can cause mothers of neonates to experience considerable distress because childcare is such an important responsibility.

The study results showed that 67% of the participants stated that they had failed to maintain their hygiene due to a lack of water. A study on urban squatters in India similarly found that a lack of hygiene due to insufficient water to bathe their children, wash clothes and dishes, and clean home spaces and lanes led to constant distress among women (Subbaraman *et al.* 2014). In addition, women and girls feel more pressure to conform to hygiene and beauty norms than do men and boys (Wutich 2009). A lack of proper hygiene among women and their neonates may lead to psychological problems and decreased well-being among mothers.

Water insecurity is a long-standing global concern, and large-scale programmes and policies have been launched to help increase water supply. Investigations of the health benefits associated with water supply in low-income countries have concentrated on the effects of water supply on incidence of communicable diseases, such as diarrhoeal diseases (Clasen *et al.* 2007; Hutton & Bartram 2008; Hunter *et al.* 2010). Unlike in other populations, few of our participants reported poor drinking water quality and illnesses resulting from unclean water. However, our results suggest that water insecurity should be measured not only by

Table 3 | The associations between household water insecurity, postnatal depression and physical HRQOL among Nepali postnatal women

Variable		Postnatal depression		Physical HRQOL	
		OR (95% CI)	P-value	Beta (SE)	P-value
Household water insecurity score		1.43 (1.01 – 2.02)	0.04	–0.11 (0.04)	0.01
Age	Years	1.09 (0.89 – 1.34)	0.39	–0.02 (0.03)	0.54
Caste	Bramhan	Ref.		Ref.	
	Chettri	8.77 (1.15 – 66.64)	0.04	0.38 (0.30)	0.21
	Newar	3.56 (0.40 – 31.84)	0.26	0.71 (0.36)	<0.05
	Janajati	2.77 (0.33 – 23.39)	0.35	0.09 (0.29)	0.74
	Dalit/Other*	Omitted		1.11 (0.72)	0.13
Educational background	No literacy/No formal education	Ref.		Ref.	
	Primary/Lower secondary school	0.05 (0.002 – 1.56)	0.09	–0.10 (0.60)	0.87
	Upper secondary school	0.05 (0.002 – 1.11)	0.06	–0.31 (0.56)	0.59
	College/University	0.06 (0.002 – 1.84)	0.11	–0.20 (0.60)	0.74
Household income	No fixed income/ < NRs. 10,000	Ref.		Ref.	
	NRs. 10,000–19,999	1.86 (0.23 – 14.76)	0.56	0.81 (0.31)	0.01
	≥NRs. 20,000	0.41 (0.02 – 7.19)	0.54	0.64 (0.32)	0.05
	Do not know/Do not want to disclose	0.06 (0.10 – 8.61)	0.94	0.93 (0.33)	0.01
Delivery type	Vaginal	Ref.		Ref.	
	Caesarean	0.64 (0.14 – 2.86)	0.56	0.10 (0.22)	0.97
Birth experience	Premiparae	Ref.		Ref.	
	Multiparae	0.20 (0.02 – 1.61)	0.13	0.24 (0.27)	0.38
Piped water supply	Continuous supply	Ref.		Ref.	
	No connected/Unstable supply	1.16 (0.17 – 8.02)	0.88	0.29 (0.32)	0.37
Physical symptoms/sickness	None	Ref.		Ref.	
	Presence	9.45 (1.60 – 56.50)	0.01	–1.12 (0.33)	0.001
Sickness of baby	None	Ref.		Ref.	
	Presence	1.48 (0.33 – 6.68)	0.61	0.02 (0.29)	0.93
Social support index	Score	0.91 (0.57 – 1.44)	0.69	0.35 (0.06)	<0.001

OR: odds ratio, CI: confidence interval, SE: standard error, Ref.: Reference.

*Dalit/other ethnicity was omitted because none of the women who were Dalit/other ethnicity had depression.

access to safe drinking water, but also by behavioural reactions and emotional distress. Anthropological research has reported that the community discourse on water insecurity relates more to physical and emotional hardships and social conditions related to restricted access to an adequate water supply than to biomedical illness (Ennis-McMillan 2001). The health effects of water insecurity and associated psychological health issues – particularly on vulnerable groups – should be explored further.

There are several limitations to this study. Although the Cronbach's coefficient alpha showed that the reliability of the HWIS was moderately acceptable, this scale was developed specifically for postnatal women. Therefore, the HWIS scores in our sample may not be able to accurately capture

the intensity of water insecurity in other populations. Expression of distress for water insecurity differs between individuals, and includes fear, worry, anger, or bother (Wutich & Ragsdale 2008). The HWIS therefore needs to be multidimensional. In addition, the EPDS is widely used for mental health assessment for postnatal women, but it is only a screening instrument for mental health and not suitable for diagnosis. Since the study participants were recruited from a tertiary hospital and the sample size was relatively small, the findings cannot be generalized to the entire population of postnatal women living in water-poor areas. In addition, we screened for depression 1 month after delivery, and the point prevalence of possible depression was 6.4% among the participants. The onset

and point prevalence of postnatal depression differs by perinatal period (Cox et al. 1993). Furthermore, the point prevalence of postnatal depression tends to increase 2 months after delivery (Gaynes et al. 2005). Hence, the prevalence of possible depression may be lower in the present study than in other empirical studies. This warrants following up on participating women for a certain duration. Finally, recall bias for reporting duration of piped water supply might have been present. To obtain a more accurate estimate of actual water distribution duration and availability of household water, a different evaluation of household water use should be considered (e.g. using a diary to record daily water use).

CONCLUSION

The current findings suggest that implementing programmes and policies to improve water supply systems in less-developed countries is important for postnatal women's psychological health. Sustainable access to safe drinking water is one of the primary targets of the Millennium Development Goals. Although the United Nations declared that worldwide access to improved drinking water sources had been achieved in 2012, many people still suffer from inadequate water supply systems and many urban cities have intermittent or highly unreliable water supply systems (Hunter et al. 2010). To prevent both physical and psychological health burdens related to water insecurity and provision of water supply, cities should focus on not only safe drinking water but also stable distribution systems. In Nepal, women are not involved in the planning, operation, or maintenance of drinking supply schemes (Bhandari et al. 2005). This context may be similar to those of other low- and middle-income countries that have limited water resources and a high prevalence of postnatal depression. Women's perspectives on the right to water should be emphasized, especially with regard to the health disparities related to water insecurity.

CONFLICT OF INTEREST

None.

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REFERENCES

- Asia Development Bank 2010 *Kathmandu Valley Water Supply and Wastewater System Improvement*. ADB, Kathmandu.
- Bhandari, B., Grant, M. & Pokharel, D. 2005 Sustainable community water: managing supply systems in the mid-hills of Nepal. *Water Policy* 7 (2), 201–214.
- Blackden, C. M. & Wodon, Q. 2006 *Gender, Time Use, and Poverty in Sub-Saharan Africa*. World Bank Publications, Washington, DC.
- Cameron, J., Hunter, P., Jagals, P. & Pond, K. 2011 *Valuing Water, Valuing Livelihoods*. IWA Publishing, London.
- Casey, P. H., Szeto, K. L., Robbins, J. M., Stuff, J. E., Connell, C., Gossett, J. M. & Simpson, P. M. 2005 *Child health-related quality of life and household food security*. *Arch. Pediatr. Adolesc. Med.* 159 (1), 51–56.
- Central Bureau of Statistics, Government of Nepal 2012 *National Population and Housing Census 2011*. Government of Nepal, Kathmandu.
- Clarke, K., Saville, N., Shrestha, B., Costello, A., King, M., Manandhar, D., Osrin, D. & Prost, A. 2014 *Predictors of psychological distress among postnatal mothers in rural Nepal: a cross-sectional community-based study*. *J. Affect. Disord.* 156, 76–86.
- Clasen, T., Schmidt, W. P., Rabie, T., Roberts, I. & Cairncross, S. 2007 *Interventions to improve water quality for preventing diarrhoea: systematic review and meta-analysis*. *BMJ* 334 (7597), 782.
- Cox, J. L., Murray, D. & Chapman, G. 1993 *A controlled study of the onset, duration and prevalence of postnatal depression*. *Br. J. Psychiatry* 163 (1), 27–31.
- Dewing, S., Tomlinson, M., le Roux, I. M., Chopra, M. & Tsai, A. C. 2013 *Food insecurity and its association with co-occurring postnatal depression, hazardous drinking, and suicidality among women in peri-urban South Africa*. *J. Affect. Disord.* 150 (2), 460–465.
- Ennis-McMillan, M. C. 2001 *Suffering from water: social origins of bodily distress in a Mexican community*. *Med. Anthropol. Q.* 15 (3), 368–390.

- Fisher, J., Mello, M. C. d., Patel, V., Rahman, A., Tran, T., Holton, S. & Holmes, W. 2012 Prevalence and determinants of common perinatal mental disorders in women in low- and lower-middle-income countries: a systematic review. *Bull. World Health Organ.* **90** (2), 139–149.
- Gao, L., Chan, S. W. & Mao, Q. 2009 Depression, perceived stress, and social support among first-time Chinese mothers and fathers in the postpartum period. *Res. Nurs. Health* **32** (1), 50–58.
- Gaynes, B. N., Gavin, N., Meltzer-Brody, S., Lohr, K. N., Swinson, T., Gartlehner, G. & Brody, S. 2005 Perinatal depression: prevalence, screening accuracy, and screening outcomes. *Evid. Rep. Technol. Assess.* **119**, 1–8.
- Hadley, C. & Wutich, A. 2009 Experience-based measures of food and water security: biocultural approaches to grounded measures of insecurity. *Hum. Organ.* **68** (4), 451–460.
- Hoekstra, A. Y., Mekonnen, M. M., Chapagain, A. K., Mathews, R. E. & Richter, B. D. 2012 Global monthly water scarcity: blue water footprints versus blue water availability. *PLoS One* **7** (2), e32688.
- Hunter, P. R., MacDonald, A. M. & Carter, R. C. 2010 Water supply and health. *PLoS Med.* **7** (11), e1000361.
- Hutton, G. & Bartram, J. 2008 Global costs of attaining the millennium development goal for water supply and sanitation. *Bull. World Health Organ.* **86** (1), 13–19.
- Koenig, H. G., Westlund, R. E., George, L. K., Hughes, D. C., Blazer, D. G. & Hybels, C. 1993 Abbreviating the Duke social support index for use in chronically ill elderly individuals. *Psychosomatics* **34** (1), 61–69.
- McDonald, R. I., Green, P., Balk, D., Fekete, B. M., Revenga, C., Todd, M. & Montgomery, M. 2011 Urban growth, climate change, and freshwater availability. *Proc. Natl. Acad. Sci. USA* **108** (15), 6312–6317.
- Pickering, A. J. & Davis, J. 2012 Freshwater availability and water fetching distance affect child health in sub-Saharan Africa. *Environ. Sci. Technol.* **46** (4), 2391–2397.
- Qi, C. & Chang, N. B. 2011 System dynamics modeling for municipal water demand estimation in an urban region under uncertain economic impacts. *J. Environ. Manage.* **92** (6), 1628–1641.
- Ray, I. 2007 Women, water, and development. *Annu. Rev. Environ. Resour.* **32**, 421–449.
- Regmi, S., Sligl, W., Carter, D., Grut, W. & Seear, M. 2002 A controlled study of postpartum depression among Nepalese women: validation of the Edinburgh postpartum depression scale in Kathmandu. *Trop. Med. Int. Health* **7** (4), 378–382.
- Ross, L. E. & McLean, L. M. 2006 Anxiety disorders during pregnancy and the postpartum period: a systematic review. *J. Clin. Psychiatry* **67** (8), 1285–1298.
- Sharkey, J. R., Johnson, C. M. & Dean, W. R. 2011 Relationship of household food insecurity to health-related quality of life in a large sample of rural and urban women. *Women Health* **51** (5), 442–460.
- Stuff, J. E., Casey, P. H., Szeto, K. L., Gossett, J. M., Robbins, J. M., Simpson, P. M., Connell, C. & Bogle, M. L. 2004 Household food insecurity is associated with adult health status. *J. Nutr.* **134** (9), 2330–2335.
- Subbaraman, R., Nolan, L., Shitole, T., Sawant, K., Shitole, S., Sood, K., Nanarkar, M., Ghannam, J., Betancourt, T. S., Bloom, D. E. & Patil-Deshmukh, A. 2014 The psychological toll of slum living in Mumbai, India: a mixed methods study. *Soc. Sci. Med.* **119**, 155–169.
- Swindale, A. & Bilinsky, P. 2006 Development of a universally applicable household food insecurity measurement tool: process, current status, and outstanding issues. *J. Nutr.* **136** (5), 1449S–1452S.
- Weaver, L. J. & Hadley, C. 2009 Moving beyond hunger and nutrition: a systematic review of the evidence linking food insecurity and mental health in developing countries. *Ecol. Food Nutr.* **48** (4), 263–284.
- World Bank 2013 Managing Nepal's Urban Transition [Webpage]. World Bank website. <http://www.worldbank.org/en/news/feature/2013/04/01/managing-nepals-urban-transition> (accessed 23 May 2014).
- World Health Organization 1996 *WHOQOL-BREF Introduction, Administration, Scoring and Generic Version of the Assessment*. WHO, Geneva.
- World Health Organization & United Nations Children's Fund Joint Monitoring Programme for Water Supply, Sanitation (JMP) 2014 *Progress on Drinking Water and Sanitation; 2014 Update*. WHO and UNICEF, New York.
- Wutich, A. 2009 Intrahousehold disparities in women and men's experiences of water insecurity and emotional distress in urban Bolivia. *Med. Anthropol. Q.* **23** (4), 436–454.
- Wutich, A. & Ragsdale, K. 2008 Water insecurity and emotional distress: coping with supply, access, and seasonal variability of water in a Bolivian squatter settlement. *Soc. Sci. Med.* **67** (12), 2116–2125.

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