

Association of Women's Empowerment With Water, Sanitation, and Hygiene (Wash) Services in Ethiopia: A Cross-sectional Analysis

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Research

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1 **Association of women’s empowerment with water, sanitation, and**
2 **hygiene (WASH) services in Ethiopia: a cross-sectional analysis**

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9 **Abstract**

10 **Background:** Access to safe drinking water, sanitation, and hygiene (WASH) services is vital
11 for human health and well-being. In Ethiopia, lack of improved WASH services has existed as
12 a health problem for many years. Empowering women is among the most important factors for
13 improving WASH services, but research-based evidence is lacking in this regard. The present
14 study was designed to analyse the association between women’s empowerment and WASH
15 services in Ethiopia.

16 **Methods:** This analysis is based on the 2016 Ethiopian Demographic and Health Survey
17 (EDHS). The survey-based Women’s emPowERment (SWPER) index approach is used to
18 develop women’s empowerment indices. The three empowerment domains used by the
19 SWPER authors include attitude to violence, social independence, and decision-making.
20 Multilevel logistic regression was used to assess the association between these domains of
21 women’s empowerment and WASH services. Estimates were presented as odds ratio (OR) and
22 expressed per one standard deviation (SD) with significance levels set at the 5% level.

23 **Results:** Overall, 90.9%, 78.4%, and 50.3% of the households included in this analysis had no
24 basic handwashing facility, improved sanitation facility, and improved water source,
25 respectively. A one SD increase in the social independence domain was associated with 16%
26 higher odds of having basic handwashing facility (AOR: 1.16; 95%CI: 1.02, 1.33). As women's
27 attitude to violence increased by one SD, the odds of having improved sanitation facility is
28 increased by 22% (AOR: 1.22; 95%CI: 1.05, 1.42). Also, a SD increase in social independence
29 domain was associated with 18% higher odds of having improved sanitation facility (AOR:
30 1.18; 95% CI: 1.04, 1.34). There was no statistically significant association between domains
31 of women's empowerment and source of water.

32 **Conclusions:** This study has shown that most of the households in Ethiopia had no access to
33 improved WASH services. Multiple regression analyses revealed that empowering women had
34 association with having basic handwashing and improved sanitation facility. The findings of
35 this study have suggestive evidence that empowering women could improve WASH services.

36 **Key words:** water, sanitation, hygiene, handwashing facility, WASH, EDHS, women's
37 empowerment, Ethiopia

38 **Background**

39 Water, sanitation, and hygiene (WASH) are vital to the health, social and economic well-being,
40 but far too little attention has been paid to these services. Whereas water refers to the operation
41 of access to safe water for drinking, sanitation refers to the access to a toilet/latrine that safely
42 separates human excreta from humans, and hygiene refers to the public health and the
43 transmission of faecal-oral disease (1). In the present study, similar concepts apply for water
44 and sanitation, while hygiene is used to refer basic handwashing service. Despite improvements
45 in the access to WASH services in recent decades, the estimated global population that had no
46 access to improved sanitation facility, basic handwashing facility, and improved water source

47 in 2017 was 55%, 40% and 29%, respectively (2). The vast majority of the population that
48 lacked access to WASH services reside in low-income countries and in rural areas (3).
49 Worldwide, in 2016, 1.9 million deaths and 123 million disability adjusted life years (DALYs)
50 lost because of inadequate WASH services (4). The WASH-related burden of deaths in under-
51 five children amounts 13% (5). Neglected Tropical Diseases (NTDs), which are associated
52 mainly with shortage of WASH services, affect more than 1 billion people (6).

53 WASH-related services are among the Sustainable Development Goals (SDGs) (7), and as
54 well, means to achieve other SDGs such as reducing maternal mortality, ending preventable
55 deaths of newborns and under-five children, ending NTDs and other waterborne diseases, and
56 reducing deaths and illness from water contamination (5, 8-10).

57 Available evidence reveals that improvement in WASH-related services is associated with a
58 marked decrease in the public health risks (9, 11, 12). However, its status in Ethiopia is
59 worrisome in that an overwhelming number of populations have no access to these services.
60 For example, in 2015, about 43% (7% urban, 51% rural) and 72% (73% urban, 72% rural)
61 Ethiopian population had no access to improved drinking water, and sanitation facility,
62 respectively (13). Again, the trend in the improvement of WASH-related services is in a very
63 slow fashion (14). Improving WASH services is critical, particularly for Ethiopia, because it is
64 associated with public health risks such as stunting (15, 16), diarrhoea (17), trachoma (18), and
65 other many intestinal parasitic infections (19)—causes of long-term disability and death. In
66 Ethiopia, about 80 percent of communicable diseases can be averted with adequate supply of
67 safe water, improved sanitation, and hygiene services (20). Moreover, the mortality rate
68 attributed to unsafe WASH services is about 30 per 100000 population (13).

69 Investing in these services is not only feasible but can also be expected to have substantial
70 health, economic and environmental benefits. Because as more households have access to

71 WASH services, robust health gains that expand to better education, sustainable job
72 opportunities, and secured and prosperous societies will be achieved (21). Therefore, to
73 efficiently allocate the available limited resource, identification of effective route of entry for
74 intervention is important.

75 As in many societies, women and girls in Ethiopia are the primary family members that are
76 impacted directly by the WASH services, and the top in Africa to spend greater than 30 minutes
77 of their time in collecting water (22). As a result, women and girls in Ethiopia may not devote
78 adequate time to their education and to other productive ventures. Women's empowerment has
79 been associated with other important public health services such as fertility preference (23),
80 improved household nutrition (24, 25), and agricultural productivity (26). In terms of WASH-
81 related services, studies showed that the connection between WASH and women is even more
82 complex (1, 27, 28), and can be linked with women's reproductive health (29).

83 Women's empowerment embodies a multitude of concepts and operates at various levels (30-
84 33). The concept is even more important in Ethiopia where there are cultural norms that favour
85 toward male in the division of labour, access to resources, and decision-making (34, 35). The
86 global woman's status indicators, which are collected by the Demographic and Health Survey
87 (DHS) program, have led to valuable theoretical and empirical contributions to the literature
88 on women's empowerment and various health outcomes around the world (36, 37). A recent
89 index called Survey-based Women's emPowERment (SWPER) index sought to synthesis
90 multiple dimensions of women's empowerment (38). It was developed and validated based on
91 fifteen items collected in the DHS surveys of 34 African countries including Ethiopia. By
92 following the same methodical approaches of this tool (38), this analysis aims to provide
93 evidence on the associations between different dimensions of women's empowerment and (1)
94 source of drinking water, (2) status of sanitation facility, and (3) availability of basic
95 handwashing facility in the household in Ethiopia.

96 **Methods**

97 **Data source and sampling methods**

98 The data source for this analysis is the 2016 Ethiopian Demographic and Health Survey (DHS).
99 EDHS is a principal source of data on population, health, environmental health, nutrition, and
100 women's status. The EDHS follows a two-stage stratified cluster sampling, in which sampling
101 points (clusters) selected from a list of enumeration areas (EAs) (primary sampling units
102 formed for the 2007 population census), and then households randomly selected from each of
103 the selected cluster. A total of 15683 women from 645 clusters included in this survey. Details
104 on sampling and data collection procedures of EDHS are described elsewhere (24).

105 **Outcome variables**

106 Table 1. Definitions of outcome variables (WASH services), based on WHO/UNICEF joint
107 report (39).

108 Table 1. Definitions of outcome variables (WASH services)

Variables	Descriptions
Basic handwashing facility	Households that had a fixed place where household members wash their hands, and those who had water plus soap on premises (confirmed by observation) at the time of the interview are labelled as having basic handwashing facility. This approach (confirmation of availability of handwashing facility and presence of water plus soap on the premises by observation) is used to estimate global status of basic handwashing facility (40).
Water source	Improved: When water source is: piped water (piped into dwelling, piped to yard/plot, piped to neighbour), public tap/standpipe, tube well, or borehole.

Unimproved: When water source is: dug well (open/protected), protected well, unprotected well, surface (spring, river, dam, lake, ponds, stream, canal or irrigation channel), protected spring, unprotected spring, rainwater, or tanker truck.

Sanitation facility **Improved:** flush toilet (flush to piped sewer system, flush to septic tank, flush to pit latrine), ventilated improved pit latrine (VIP), pit latrine with slab or composting toilet.

Unimproved: flush to somewhere else but do not know where, pit latrine without slab/open pit, no facility, no facility/bush/field, bucket toilet and hanging toilet/latrine.

109 **Exposure variable**

110 The main exposure variables are deferent dimensions of women’s empowerment. Women’s
111 empowerment indices were constructed by adopting the procedure analogous to the SWPER
112 index that used by Ewerling (38). The SWPER indices were computed based on fifteen items
113 extracted from DHS surveys of 34 African countries. A principal component analysis (PCA)
114 was applied on 15 variables that were used by Ewerling to measure women’s empowerment
115 from different perspectives. Before PCA, these items were re-categorised so that higher values
116 were given to categories indicating greater empowerment (Additional file 1: Table S1). The
117 three principal components retained were attitude to violence, social independence, and
118 decision-making. These components with the items loaded on them are presented as a
119 supplementary file (Additional file 1: Table S2).

120 As most of these items that used to develop empowerment indices were asked only for currently
121 married or partnered women, these analyses were restricted to this group. By using the same
122 formula with SWPER computation, the individual standardized scores for the three principal
123 components can be computed as:

124
$$S_{ij} = \frac{[[\lambda_{1j}(x_{1i} - \bar{x}_1)] + [\lambda_{2j}(x_{2i} - \bar{x}_2)] + \dots + [\lambda_{15j}(x_{15i} - \bar{x}_{15})]]}{\sigma_j} \dots (1)$$

125 where S_{ij} is the individual standardized score for individual i and component j ; x_{1j}, \dots, x_{15j} are
 126 the individual values for variables x_1 - x_{15} included in the PCA analyses; σ_j is the standard
 127 deviation (SD) of the predicted scores of each component j . The weight given to each of the 15
 128 variables in each component j is estimated using equation 2 below and presented (Additional
 129 file 1: Table S3).

130
$$\lambda_{vj} = \frac{\varphi_{vj}}{\sigma_v} \dots (2)$$

131 where φ_{vj} is the PCA loading for each of the variable v in each domain j and σ_v is the SD of
 132 each variable v in the combined dataset.

133 The above equation can be simplified as:

134
$$S_{ij} = \frac{[-(\sum_{v=1}^{15} \lambda_{vj} \bar{x}_v) + (\sum_{v=1}^{15} (\lambda_{vj} x_{vi}))]}{\sigma_j} \dots (3)$$

135 Based on this, the three dimensions of women's empowerment can be estimated as:

136
$$\text{Attitude to violence score} = \frac{[(-0.180) + (\sum_{v=1}^{15} (\lambda_{v1} x_{vi}))]}{1.953} \dots (\text{component 1})$$

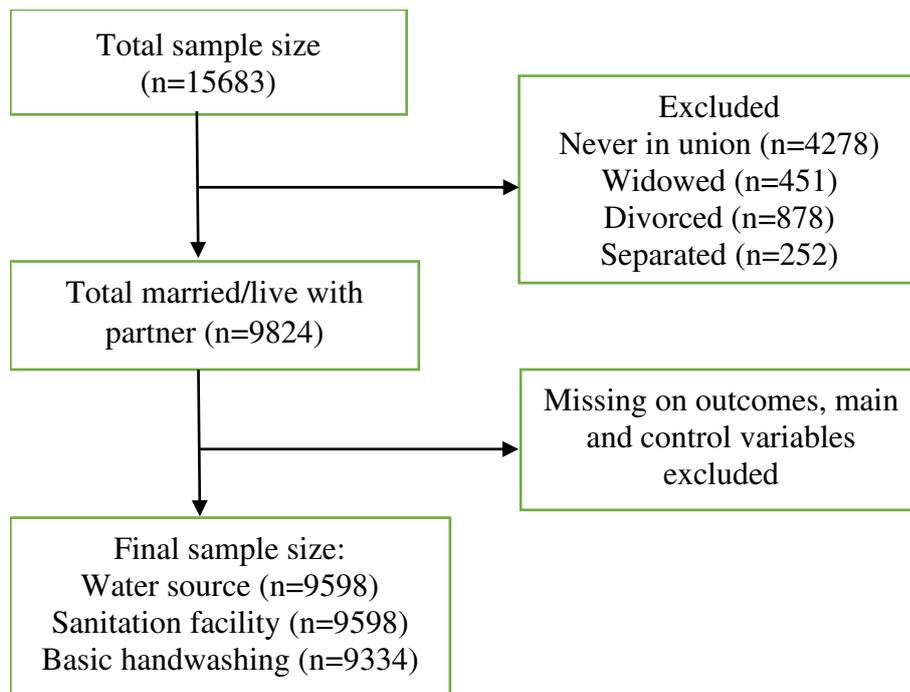
137
$$\text{Social independence score} = \frac{[(-5.762) + (\sum_{v=1}^{15} (\lambda_{v2} x_{vi}))]}{1.407} \dots (\text{component 2})$$

138
$$\text{Decision making score} = \frac{[0.210) + (\sum_{v=1}^{15} (\lambda_{v3} x_{vi}))]}{1.356} \dots (\text{component 3})$$

139 Where x_{vi} is the value of variables v for each individual i and $\lambda_{v0} - \lambda_{v3}$ are the variable weights
 140 that is found in the supplementary file (Additional file 1: Table S3). These indices standardized
 141 to have a normal distribution with mean = 0 and SD = 1.

142 **Statistical analysis**

143 Chi-square tests and student's t-tests were used for categorical and continuous variables,
144 respectively, to compare differences between improved and unimproved water source,
145 improved and unimproved sanitation facility, and presence and absence of basic handwashing
146 facility. As a result of a multistage cluster sampling approach used by the EDHS, the data
147 obtained from this survey form hierarchy in which households nested within a cluster.
148 Therefore, households from the same cluster may exhibit characteristics that are correlated with
149 one another than with households from different cluster. To account this, multilevel logistic
150 regression models used to estimate associations of water source, status of sanitation facility,
151 and availability of basic handwashing facility with women's empowerment domains. To be
152 able to use multilevel modelling with EDHS data together with survey commands, a weight
153 must be applied for each level, but there is only one weight available in the EDHS data. In this
154 study, the recently developed methods and the STATA codes provided for estimating cluster
155 weights for multilevel model in the DHS data were used (41). Households were the first-level
156 units, whereas clusters were the second-level units, and adjusted for other covariates
157 (Additional file 1: Table S4). Estimates were presented as odds ratio (OR) with 95% confidence
158 intervals (CI) and expressed per one SD increase in each empowerment domain. The DHS
159 supplied weight variable was used to account the sampling strategies and non-response. All
160 analyses used Stata 14 (College Station, TX: StataCorp LLC).



161

162 Figure 1. The flowchart for the selection of sample included in the analysis, using the 2016

163 EDHS data

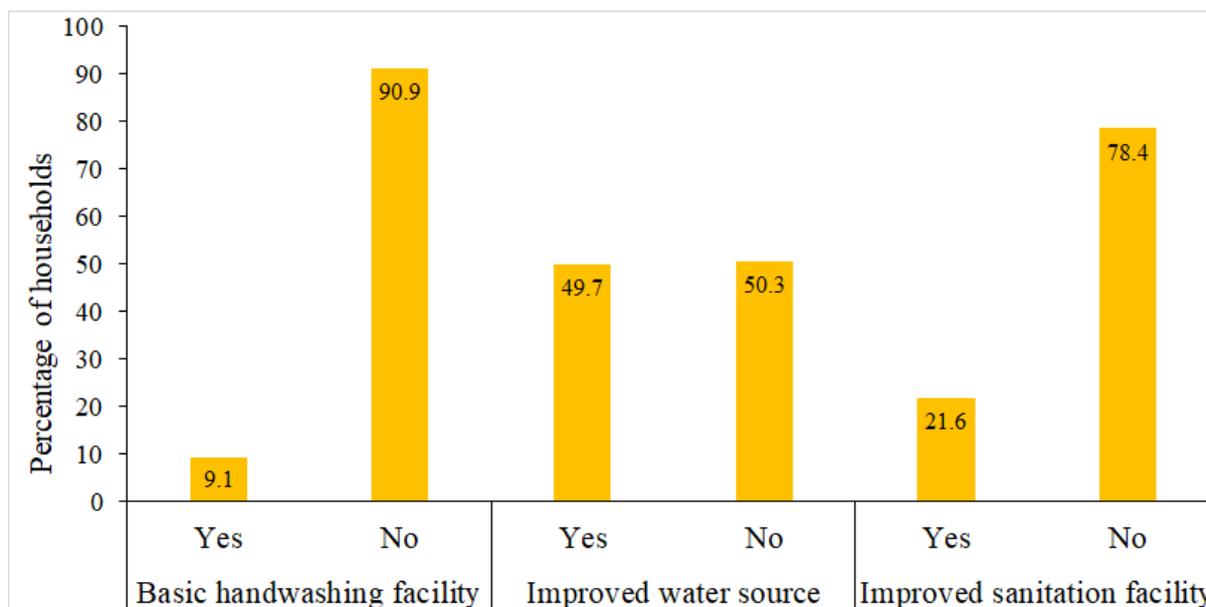
164 **Results**

165 Figure 2 portrays percentage of households having WASH services in Ethiopia, based on the

166 2016 EDHS. Only nine percent (9.1%) of households had basic handwashing facility. About

167 three-fifths (78.4%) and almost half (49.7%) of households had no improved sanitation facility

168 and improved water source, respectively (Figure 2).



169

170 Figure 2. Percentage of households with and without WASH services in Ethiopia, EDHS
 171 2016

172 Table 2 shows household characteristics and their crude association with WASH services in
 173 Ethiopia. Overall, 176 (10.0%), 553 (30.0%) and 1017 (55.1%) of households that were headed
 174 by female had basic handwashing facility, improved sanitation facility and improved water
 175 source, respectively. Of all households that had television, 514 (26.3%) had basic handwashing
 176 facility. Also, of the total households that had television, 1357 (68.6%) and 1770 (89.4%) of
 177 them had improved sanitation facility and improved water source, respectively. There was no
 178 basic handwashing facility in 4035 (86.2%) of households that had improved water source. The
 179 vast majority, 4450 (95.6%) of households that reported as having no improved water source
 180 had no basic handwashing facility. There was no basic handwashing facility in 1562 (76.8%)
 181 of households that had improved sanitation facility and in 6923 (94.8%) of households where
 182 there was no improved sanitation facility. Of those households that had improved water source,
 183 3120 (65.5%) of them had no improved sanitation facility. Results also showed that possession
 184 of all the WASH components were increased with wealth status (Table 2).

185 Table 2. Binary associations of water, sanitation, and handwashing services with other household characteristics (Chi-square test), 2016 EDHS

Variables		Basic handwashing (n=9334)		Sanitation facility (n=9598)		Water source (n=9598)	
		No	Yes	Unimproved	Improved	Unimproved	Improved
Gender of HH head*	Male	6898 (91.1)	673 (8.9)	6236 (80.4)	1517 (19.6)	4004 (51.6)	3749 (48.4)
	Female	1587 (90.0)	176 (10.0)	1292 (70.0)	553 (30.0)	828 (44.9)	1017 (55.1)
Radio*	Yes	2464 (84.8)	441 (15.2)	1997 (67.2)	974 (32.8)	1150 (38.7)	1821 (61.3)
	No	6021 (93.7)	408 (6.3)	5531 (83.5)	1096 (16.5)	3682 (55.6)	2945 (44.4)
TV*	Yes	1438 (73.7)	514 (26.3)	622 (31.4)	1357 (68.6)	209 (10.6)	1770 (89.4)
	No	7047 (95.5)	335 (4.5)	6906 (90.6)	713 (9.4)	4623 (60.7)	2996 (39.3)
Household wealth*	Poorest	2652 (98.3)	46 (1.7)	2757 (96.5)	100 (3.5)	2078 (72.7)	779 (27.3)
	Poorer	1388 (96.7)	47 (3.3)	1363 (93.2)	99 (6.8)	909 (62.2)	553 (37.8)
	Middle	1249 (95.1)	64 (4.9)	1221 (91.5)	113 (8.5)	770 (57.7)	564 (42.3)
	Richer	1163 (92.2)	98 (7.8)	1139 (89.0)	141 (11.0)	702 (54.8)	578 (45.2)
	Richest	2033 (77.4)	594 (22.6)	1048 (39.3)	1617 (60.7)	373 (14.0)	2292 (86.0)
Place of residence*	Urban	1836 (77.2)	542 (22.8)	886 (36.7)	1531 (63.3)	280 (11.6)	2137 (88.4)
	Rural	6649 (95.6)	307 (4.4)	6642 (92.5)	539 (7.5)	4552 (63.4)	2629 (36.6)
Time to fetch water*	<30 minutes	4430 (88.1)	600 (11.9)	3516 (67.7)	1675 (32.3)	2219 (42.8)	2972 (57.2)
	≥30 minutes	4055 (94.2)	249 (5.8)	4012 (91.0)	395 (9.0)	2613 (59.3)	1794 (40.7)
Water source*	Improved	4035 (86.2)	643 (13.8)	3120 (65.5)	1646 (34.5)	N/A	N/A
	Unimproved	4450 (95.6)	206 (4.4)	4408 (91.2)	424 (8.8)	N/A	N/A
Sanitation facility*	Improved	1562 (76.8)	472 (23.2)	N/A	N/A	N/A	N/A
	unimproved	6923 (94.8)	377 (5.2)	N/A	N/A	N/A	N/A

186 *showed significant association at $p < 0.05$ with all WASH components; N/A: not applicable (chi-square test not conducted)

187 As table 3 shows, there is a significant difference between the two groups (improved vs.
 188 unimproved or available vs. not available). It is apparent from this table that all the
 189 empowerment domains were associated with having improved water source, improved
 190 sanitation facility and basic handwashing facility. The mean values for all the domains were
 191 positive for the group with improved/available WASH services, which implied that women’s
 192 empowerment in each domain for the group with improved WASH services was greater than
 193 zero (above the mean) (Table 3).

194 Table 3. Proportion of WASH services by women’s empowerment domains, student’s t-test,
 195 EDHS 2016

WASH services status	Women’s empowerment domains					
	Attitude to violence*		Social independence*		Decision-making*	
	n	Mean (±SD)	n	Mean (±SD)	n	Mean (±SD)
Water						
Improved	4164	0.13 (0.94)	4164	0.15 (1.140)	4164	0.14 (1.06)
Unimproved	4415	-0.19 (0.95)	4415	-0.26 (.78)	4415	-0.16 (1.10)
Combined	8579	-0.04 (0.96)	8579	-0.06 (1.00)	8579	-0.01 (1.09)
Sanitation						
Improved	1739	0.47 (0.81)	1739	0.59 (1.33)	1739	0.37 (1.02)
Unimproved	6840	-0.17 (0.95)	6840	-0.23(0.81)	6840	-0.11 (1.09)
Combined	8579	-0.04 (0.96)	8579	-0.06 (1.00)	8579	-0.01 (1.09)
Handwashing facility						
Available	716	0.40 (0.89)	716	0.67 (1.41)	716	0.33 (0.92)
Not available	7628	-0.07 (0.95)	7628	-0.12 (0.92)	7628	-0.05 (1.10)
Combined	8344	-0.03 (0.96)	8344	-0.05 (1.00)	8344	-0.01 (1.09)

196 *significant at p<0.05; SD: standard deviation

197 Table 4 presents the associations between different domains of women’s empowerment and
 198 WASH from the two-level logistic regression models. In the multivariable model, a one SD
 199 increase in the social independence domain is associated with 16% higher odds of having basic
 200 handwashing facility (AOR: 1.16; 95%CI: 1.02, 1.33). When attitude to violence domain
 201 increased by one SD, the odds of having improved sanitation facility is increased by 22%
 202 (AOR: 1.22; 95%CI: 1.05, 1.42). Also, a SD increase in social independence domain was

203 associated with 18% higher odds of having improved sanitation facility (AOR: 1.18; 95% CI:
 204 1.04, 1.34). There was no statistically significant association between these domains of
 205 women’s empowerment and source of water (Table 4). Of the included covariates, having
 206 television and household wealth index associated with all WASH services. In addition, place
 207 of residence was associated with source of water and sanitation facility (Additional file 1: Table
 208 S4).

209 Table 4. Association of domains of women’s empowerment with WASH services, results
 210 from two-level logistic regression, 2016 EDHS

Empowerment domains	Basic handwashing facility OR (95%CI)	Sanitation facility OR (95%CI)	Water source OR (95%CI)
	Crude models		
Attitude to violence	1.39 (1.15, 1.68)**	1.44 (1.22, 1.68)***	1.02 (0.86, 1.19)
Social independence	1.41 (1.23, 1.62)***	1.36 (1.17, 1.58)***	1.15 (1.03, 1.28)**
Decision making	1.24 (1.08, 1.43)**	1.13 (1.00, 1.27)**	1.10 (0.99, 1.21)
	Adjusted models		
Attitude to violence	1.08 (0.90, 1.31)	1.22 (1.05, 1.42)**	0.94 (0.80, 1.11)
Social independence	1.16 (1.02, 1.33)**	1.18 (1.04, 1.34)**	1.09 (0.98, 1.22)
Decision making	1.13 (0.97, 1.31)	1.03 (0.91, 1.18)	1.06 (0.95, 1.18)

211 *Caption:* **p<0.05, ***p<0.001. Basic handwashing facility: controlled for gender of head of
 212 the household (male/female); having radio (yes/no); having television (yes/no); household
 213 wealth index (poorest/poorer/middle/richer/richest); place of residence (urban/rural); time to
 214 fetch water (<30 minutes/≥30 minutes); water source (improved/unimproved); and sanitation
 215 facility (improved/unimproved). Sanitation facility: controlled for all the covariates controlled
 216 for basic handwashing facility. Water source: controlled for all the covariates controlled for
 217 basic handwashing facility, except for time to fetch water; and for sanitation facility.

218 **Discussion**

219 This study has analysed the three key aspects of public health services including water,
 220 sanitation, and handwashing (WASH), with respect to different dimensions of women’s

221 empowerment in Ethiopia. The results indicate that an overwhelming number of households
222 were reliant on unimproved water source and sanitation facility, and had no basic handwashing
223 facility. Both (i.e., women's empowerment and WASH services) are cross-cutting components
224 of the Sustainable Development Goals (SDGs) and have a considerable association in Ethiopia
225 (10). Because both, as a goal, are not only an end in themselves, but they are also a means
226 through which to accelerate the progress of other SDGs (10).

227 Lack of access to WASH at home has a negative impact on household's health and well-being,
228 particularly for women and girls (27, 29). Ethiopian government designed different strategies
229 with a view to achieving universal coverage of primary health care among its citizen in the
230 context of limited resources. One of those strategies is the Health Sector Development Plans
231 (HSDPs), which has been implemented successively (42). In this successive HSDP program,
232 there is health extension program (HEP) component, which has a total of 16 packages under
233 four major program areas, of which seven are related directly to environmental health services
234 (43, 44). Despite these considerable efforts, the current analyses noted that the proportion of
235 the population without WASH-related services is huge. Without fast-tracked investment in
236 these services, the country could not achieve the planned SDGs targets that related to these
237 services.

238 Another crucial SDG, which is aimed at accelerating sustainable development, is the promotion
239 of women's empowerment and gender equality (45). In the current study, the methodically
240 designed and validated SWPER index (38) allowed me to see the associations between
241 women's empowerment and WASH-related services in Ethiopia, while controlling for
242 household wealth index, means of communication, gender of head of the household and place
243 of residence. Positive associations between empowerment domains and having improved
244 sanitation service and basic handwashing facility were observed.

245 Specifically, with respect to the sanitation service, results revealed that those who had negative
246 attitude to violence against women and those who were socially independent reported as having
247 improved sanitation facility. The observed association between women's empowerment and
248 status of sanitation facility might be explained, at least partly, as when women have the power
249 to oppose violence against themselves in the household and are socially independent, they will
250 have influence both in their household and in their society, which could in turn, create access
251 to education and material assets (46-48). Further, when women are socially independent, they
252 could participate in social organizations and share knowledge about the benefit of improved
253 sanitation service so that struggle to establish the service. In the same way, a study from rural
254 part of Ethiopia showed that having good information about the benefits of WASH services
255 was associated with having these services at home (49, 50). Though it had variation in the types
256 of indicators used to measure empowerment, this finding broadly supports the work of other
257 studies in this area linking sanitation with women's empowerment (48, 51). As it can be seen
258 in the supplement file, the control variables that showed association with having improved
259 sanitation service include possession of television, place of residence and household wealth
260 index, which is in line with existing evidence (52).

261 With regard to basic handwashing facility, only the social independence domain of women's
262 empowerment was associated with higher odds of having basic handwashing facility at home.
263 Handwashing is a simple, cost effective and yet a very effective service to substantially
264 improve the health, education, social and economic status of a society (53). This association of
265 women's empowerment, particularly with the social independence dimension, and having basic
266 handwashing facility could be as women involved actively in social organisations, they can
267 share and gain knowledge about the importance of washing hands at all critical times, this could
268 result in improved ownership of handwashing facilities (54, 55). Presence of television and

269 improved sanitation facility in the household, and household wealth index were the three
270 control variables that showed significant association with having basic handwashing facility.

271 The results of this study did not show any significant association between these women's
272 empowerment domains (i.e., attitude to violence, social independence, and decision-making)
273 and having improved water source in the household. It is difficult to explain this result, but it
274 might be related to the fact that having access to improved water source can be affected by
275 factors other than women's status both in the household and in the community, including
276 availability, accessibility, continuity of service, and affordability (52, 56). These and other
277 determinants of having improved water source could make this service beyond woman's status
278 in each household or community. Of the control variables included in the model that dealt with
279 the association between empowerment domains and water source, possession of television,
280 household wealth index and place of residence showed significant association.

281 This study makes several contributions to the existing body of knowledge. Both WASH-
282 services and women's empowerment are key global developmental agendas, and also a means
283 to accelerate other SDGs (10). The use of SWPER index—a robust and validated tool—enabled
284 a compressive assessment of WASH services from the perspective of women's status in
285 Ethiopia. The use of multilevel logistic regression to account correlation of WASH services in
286 households that were found in the same cluster could increase robustness of the estimates. This
287 study is one of the very few studies that assessed the relationship between women's
288 empowerment and WASH services in the households at a national-level so that the findings
289 have important implications for planning and implementation of gender responsive WASH
290 programs.

291 There are many factors that make these results should be interpreted with caution. As they are
292 based on a cross-sectional data, it is important to bear in mind the possible bias in these

293 findings. The SWPER index considered only married or partnered women because the DHS
294 collects woman's status indicators for these groups of women only. As a result, these analyses
295 did not consider single, widowed, divorced, and separated women, which could have led to
296 under or over estimation of the results. Another important limitation of the current analyses is
297 that better WASH services may lead to empowerment (e.g., women spending more time on
298 educational and income-generating activities or stay healthy from WASH-related ill-health so
299 that gain time to involve in social and political organizations) (51). Furthermore, there could
300 be other factors confounding or mediating the current associations.

301 **Conclusions**

302 This observational study suggests that involving women in an effort to improve WASH-related
303 services, especially in sanitation and handwashing services could help to increase the coverage.
304 Though several questions remain unanswered at present, these results highlight a means with
305 which to accelerate progress towards many SDGs at the same time. The findings of this study
306 can help as an evidence for government and non-governmental organisations (NGOs) working
307 in WASH-related sectors to take contextualised gender norms in their planning and
308 implementation. Finally, availability of sanitation and handwashing facilities could not be
309 necessarily indicating practice, which is more of behavioural so that further study, which takes
310 this into account, will need to be undertaken.

311 **Supplementary information**

312 Supplementary file 1

313 **Table S1.** Coded/scaled items used in the development of woman's empowerment index.

314 **Table S2.** Domains of women's empowerment with items in the component.

315 **Table S3.** List of variables used in the PCA, component loadings and weight of each variable
316 and all items required to compute standard score of women's empowerment in each
317 component/domain on the sample selected for WASH services.

318 **Table S4.** Association of domains of women’s empowerment with WASH services, full model
319 results from two-level logistic regression, 2016 EDHS.

320 **Abbreviations**

321 AOR: adjusted odds ratio; CI: confidence interval; DHS: Demographic and Health Survey;
322 EDHS: Ethiopian Demographic and Health Survey; EAs: enumeration areas; NTDs: neglected
323 tropical diseases; NGOs: non-governmental organizations; OR: odds ratio; PCA: principal
324 component analysis; SD: standard deviation; SDGs: Sustainable Development Goals; SWPER:
325 survey-based women’s empowerment; UNICEF: united nations international children’s
326 emergency fund; WASH: water, sanitation, and hygiene; WHO: World Health Organization.

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329 this analysis, and also to the authors of SWPER index’s developers.

330 **Authors’ contribution**

331 Not applicable.

332 **Availability of data and materials**

333 The dataset supporting the conclusions of this article is available in the DHS program website
334 and can be granted upon reasonable request (available at: <http://dhsprogram.com>). Further
335 codes and formulas that were used to produce these results are available upon request from the
336 author.

337 **Ethics approval and consent to participate**

338 The survey was approved by the National Research Ethics Review Committee of Ethiopia and
339 ORC Macro Institutional. The author got permission from ICF-DHS program on August 26,
340 2020, and there were no names of individuals or household addresses in the data file received.

341 Author got permission from ICF-DHS program to use the DHS data, accessed online
342 (<http://dhsprogram.com>).

343 **Consent for publication**

344 Not applicable.

345 **Competing interests**

346 The author declared that there is no competing interest.

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504

Figures

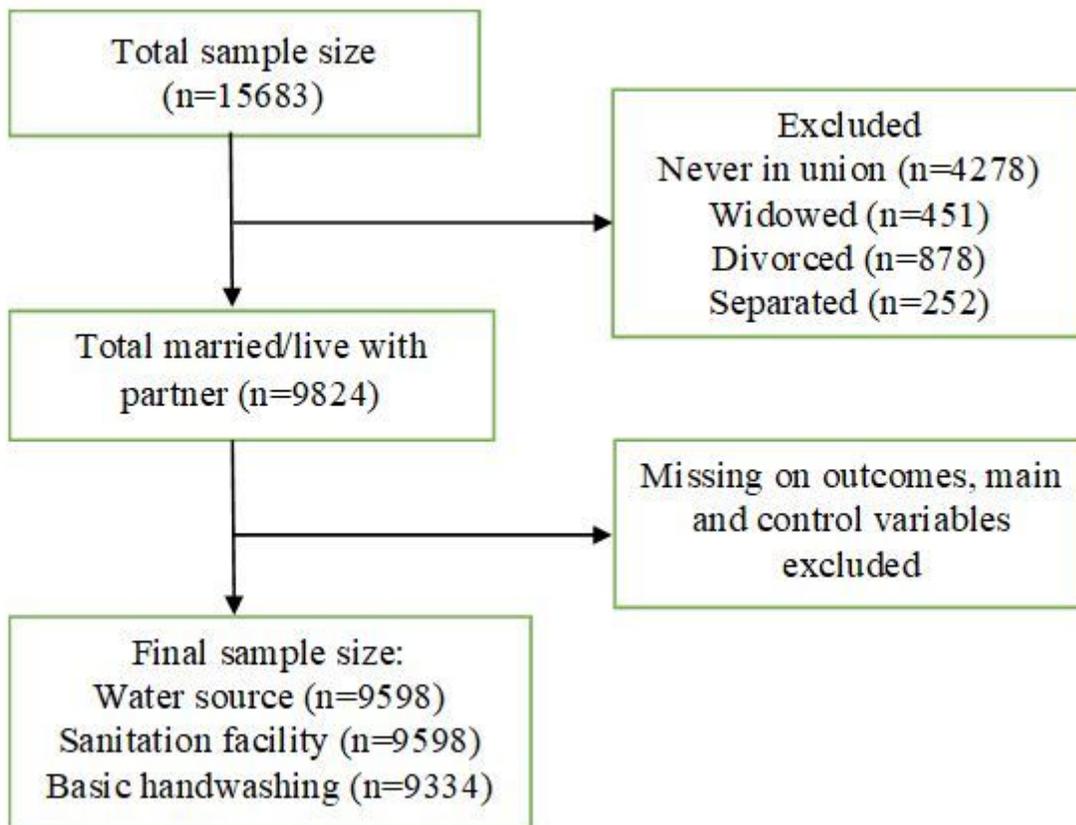


Figure 1

The flowchart for the selection of sample included in the analysis, using the 2016 EDHS data

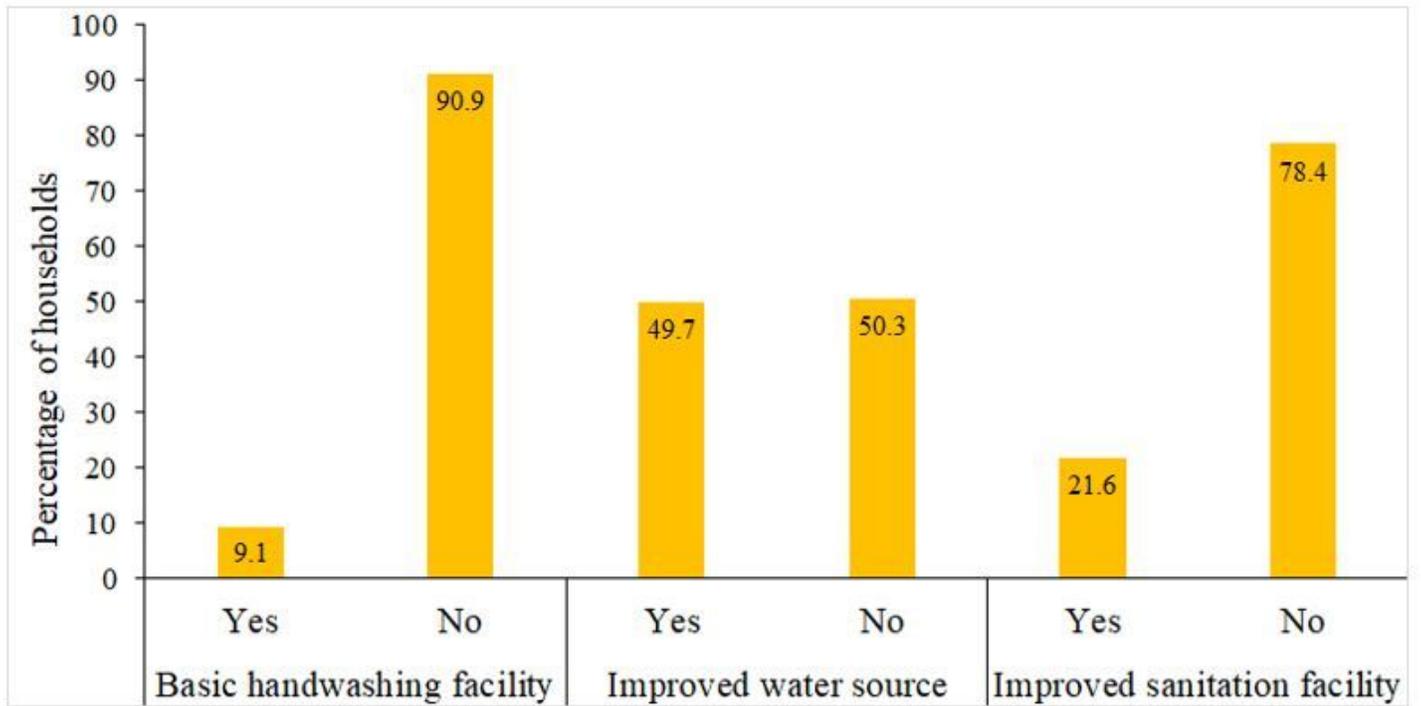


Figure 2

Percentage of households with and without WASH services in Ethiopia, EDHS 2016

Supplementary Files

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