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1 **Title: Nursing Workload in ICUs and the Influence of Patient and Nurse**
2 **Characteristics**

3 **Kolsoom Nasirizad Moghadam MScN | Minoo Mitra Chehrzad PhD | Shademan Reza**
4 **Masouleh MScN | Abbas Mardani MScN | Maryam Maleki MScN | Elham Akhlaghi MScN**
5 **| Celia Harding PhD**

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7

8 **Abstract**

9 **Background:** Understanding factors that can potentially influence patient care and nursing
10 workload in intensive care units is important. Previous studies have shown contradictory outcomes
11 about the relationships between nursing workload and patient and nurse characteristics.

12 **Aims and objectives:** This study aimed to investigate nursing workload in intensive care units
13 and examine the association between this in relation to patient and nurse characteristics.

14 **Design:** A cross-sectional design was conducted.

15 **Methods:** All nurses who were working in the intensive care units of five hospitals and met the
16 study criteria were enrolled in the study. Two demographic questionnaires collected nurse and
17 patient demographic information. The Nursing Activities Score was applied to determine nursing
18 workload in three shifts (morning, evening, night) for each nurse. Data were analyzed using the
19 independent sample t-test, one-way analysis of variance, and multivariable linear regression
20 analysis.

21 **Results:** The Nursing Activities Score was calculated for 509 patients who were under the care of
22 the 105 intensive care unit nurses. The mean (SD) nursing activities score was 72.84% (22.07%).
23 Morning shifts, male patients, medical treatments, and referred patients from the emergency ward
24 and other intensive care units imposed a higher workload for nurses. Specifically, female nurses,
25 increased number of patients receiving care, and increased patient length of intensive care unit
26 stay were directly associated with increased nursing activities scores. Work in surgical and burn
27 intensive care units were inversely associated with the nursing activities score.

28 **Conclusion:** This study suggests that the workload of nurses in intensive care units can be affected
29 by both nurse and patient characteristics.

30 **Relevance to clinical practice:** The findings can be used to ensure appropriate staffing of
31 intensive care units by nurses. However, nurse and patient characteristics should not be considered
32 as the only factors which influence nursing workload in intensive care units.

33 **Key words:** *Critical care; ICU; Intensive care units; Nursing; Workload*

34

35 1. INTRODUCTION

36 Health-care workers are crucial in supporting and caring for patients (Heckemann et al., 2015).
37 Within typical health organizations, nurses are the largest workforce and play a key role in the
38 quality of care and health promotion (Maenhout and Vanhoucke, 2013). They include 62% of all
39 the hospital staff (Momennasab et al., 2017). According to the National Association of Safety
40 Professionals in the United States, nursing is one of the forty professions with a high prevalence
41 of work-related stress (Yusefi et al., 2019). For that reason, workload is known to influence the
42 behavior and performance of nurses in the workplace (Holland et al., 2019). Generally, the nursing
43 workload is determined by time spent on patient care, nursing activities, and the skills needed to
44 care for the patient (Myny et al., 2012). The nursing staff workload is clearly related to patient
45 safety, quality of care, and cost of health care (Swiger et al., 2016).

46 The Intensive Care Unit (ICU) is an environment that provides care for patients with severe clinical
47 conditions which require ventilation and acute medical clinical care (Ferreira et al., 2017). Nurses
48 in ICUs have extensive and intense duties with limited variation in tasks, exposing them to
49 extremely high workloads both physically and mentally (Mohammadi et al., 2015). There can be
50 a need to react to both the demands of patients as well as their families. In addition, they are
51 frequently making many decisions in relation to the urgent and critical conditions of patients' lives
52 (Mohammadi et al., 2015). Abbey et al. (2012) report that nurses in the ICU perform 3,081
53 different activities during the day, 43% of which are performed simultaneously. Consequently,
54 nurses may be at risk of making more errors with ICU patient care procedures, thus impacting on
55 patient safety. In the ICU, the high workload and the low number of nurses per patient increases
56 the risk of nosocomial infections in patients and mortality. Therefore, the ICU in the hospital is a

57 stressful work setting due to the complexity of patients and the high need for direct patient care
58 (Hoogendoorn et al., 2019).

59 Given the importance of nursing workload in ICU and the factors that can affect it, this study aimed
60 to determine the nursing workload in the ICUs and examine the association between nursing
61 workload and patient and nurse characteristics.

62 **2. METHODS**

63 **2.1. Design and Participants**

64 A cross-sectional study was conducted on nurses and their patients under their care in the ICUs of
65 five teaching hospitals affiliated to the ××× University of Medical Sciences, Rasht, Iran in 2015-
66 2016.

67 In this study inclusion criteria for the recruitment of participants included: having an
68 undergraduate/postgraduate degree in nursing, being responsible for the direct care of at least one
69 patient alone during the shift, having at least one year's experience working in an ICU, having
70 direct face to face care of a patient at least 4 hours in ICU per shift, and provision of signed consent
71 to participate in the study. The exclusion criteria in this study included nurses who did not meet
72 the inclusion criteria.

73 For sampling, the researchers contacted the study ICUs, then used face to face interviews to inform
74 124 nurses of the project and the participant inclusion criteria. Nurses responded to the researchers
75 if they were interested. The nurses were screened by the study team to ensure they met the inclusion
76 criteria.

77 **2.2. Measures**

78 **2.2.1. Demographic Data Questionnaires**

79 Two demographic data questionnaires were developed based on the review of the literature to
80 collect demographic characteristics of nurses and the patients in their care. Nurses' demographic
81 data questionnaires included questions about a nurse's gender, marital status, educational level,
82 work experience, weekly working hours, employment at the other health care centers, resting
83 before and after the work shift and type of ICU worked in. Patients' demographic data
84 questionnaires contained questions about patients' gender, age, treatment types, referral sources,
85 and length of ICU stay. Content and face validity methods were applied to confirm the validity of
86 these questionnaires.

87 **2.2.2. Nursing Activities Score**

88 The Nursing Activities Score (NAS) was used in this study to determine nursing workload. The
89 NAS designed by Miranda et al. (2003) measures the nursing workload in ICUs. This instrument
90 consists of 23 items which are divided into seven major categories including basic measures,
91 ventilation support, cardiovascular support, renal support, neurological support, metabolic support,
92 and specific intervention. Each item is scored based on the amount of time the nurse spends on
93 patient care. Although the original version of the NAS was validated to measure the workload of
94 nursing over a 24 hour period, the modified version of this tool was validated by Debergh et al.
95 (2012) to measure nursing workload per shift. In fact, for each patient, the scores of the NAS were
96 calculated during each shift unless the time spent with a patient was less than 4 hours. The NAS
97 ranges from 0 to 177 % that indicates the sum of scores of 23 items which demonstrates the
98 percentage of time spent by a nurse on care-related tasks per ICU patient per 24 hours. Each NAS
99 point corresponds to 14.4 minutes. Ideally, one nurse who provides care for two patients will obtain
100 a score of 50% for each patient. A NAS of 100% is the ideal score for a nurse per shift in a 24-h
101 period and would demonstrate that the nurse spent 100% of the working time caring directly for

102 patients. A NAS of above 100% indicates that more than one nurse is needed to perform caring
103 activities. Therefore, a NAS of 177% also would equal 1.77 full-time equivalent ICU nurse time
104 (Miranda et al., 2003, Debergh et al., 2012).

105 To evaluate the validity of the NAS, the original version with the available Farsi version (translated
106 by Alizadeh et al., (2015)) was provided to 10 faculty members of the nursing school who
107 specialize in this area. After collecting their opinions, corrective feedback was considered and the
108 results (content validity ratio (CVR) = 93% and content validity ratio (CVI) = 90%) indicated a
109 high validity of the Farsi version of the NAS. In addition, the equivalent reliability method was
110 used to determine the reliability of the NAS. The NAS was completed by two evaluators
111 simultaneously and separately for 17 nurses who were providing nursing care for ICU patients.
112 The results showed there was a high correlation between the scores of two evaluators based on the
113 Pearson correlation coefficient ($r = 0.81$ and $p < 0.001$). In addition, there was no significant
114 difference between the mean of the two evaluator scores based on a paired t-test ($p = 0.72$).

115 **2.3. Data Collection**

116 Data were collected in six adult ICUs (two general ICUs with 19 beds, one neurosurgical ICU with
117 8 beds, one cardiac surgery ICU with 6 beds, one obstetric surgery ICU with 3 beds, and one burn
118 ICU with 4 beds) of 5 hospitals during a fourth-month period from November 2015 to February
119 2016. The demographic questionnaire was completed on paper by the nurses and the patient
120 demographic questionnaire was completed by the researchers during the study. The NAS was
121 completed on paper for each nurse in three shifts (morning, evening, night). The researchers
122 completed the NAS instrument in three mentioned shifts for each patient under the care of the
123 nurses participating in the study based on direct observation of nursing activities, the information
124 in the patient records and nursing reports. If the nurses were responsible for taking care of two

125 patients, the NAS was completed for each patient separately. Next, to obtain the score of the
126 workload per shift, the scores of the NAS for each patient were summed together. Finally, the
127 mean scores of the NAS in three shifts (morning, evening and night) were considered in relation
128 to nursing workload.

129 **2.4. Ethical Considerations**

130 ××× University of Medical Sciences approved the study protocol which was assigned the following
131 code: IR.GUMS.REC.1394.286. The necessary permissions were obtained from the hospital
132 authorities prior to the sampling. Next, information about the study was given to study participants
133 (nurses and their patients/ patient companions). Then, the informed consent form was signed by
134 participants who agreed to participate in this study. They were informed that they could opt-out of
135 the study at any time without being penalized.

136 **2.5. Data Analysis**

137 Data were analyzed using the SPSS v. 25 software (IBM, Armonk, NY, USA) through descriptive
138 and inferential statistics. Frequency and percent for qualitative variables and mean and standard
139 deviation for quantitative variables were used to describe participants' characteristics. Nursing
140 workload was described using means and standard deviations. In addition, an independent sample
141 t-test and One-Way ANOVA were performed to compare nursing workload according to working
142 shifts, patient genders, patient treatment types, and patient admission referrers. Moreover,
143 multivariable linear regression analysis using the SATA software (Version 15, Stata Corporation,
144 and College Station, TX, USA) was conducted to investigate nursing workload association with
145 characteristics of nurses and patients. P-value < 0.05 was considered as a significant level.

146 **3. RESULTS**

147 Out of 124 nurses who work in six ICUs 7 nurses (5.6%) declined to participate in the study and
148 12 nurses (9.7%) including head nurses and assistant head nurses were excluded because they were
149 not directly looking after patients. A total of 105 nurses (84.7%) who met the inclusion criteria
150 were enrolled in the study. The majority of nurses in this study were female (96.2%), between the
151 ages of 30-40 years old (61%), and married (59%). Most of them had a bachelor's degree in nursing
152 (94.3%). Only 17.1% of nurses were employed at the other healthcare centers. In addition, 45.7%
153 of nurses worked in general ICUs, 19% in a neurosurgical ICU, 20% in a cardiac surgery ICU,
154 10.5% in a obstetric surgery ICU, and 4.8% in a burns ICU were employed. The burns ICU had
155 14 nurses but due to a lack of patients at the time of the study only 5 nurses participated. Moreover,
156 the mean (SD) of nurses' resting before and after the work shift was 33.43 (13.44) and 30.91
157 (11.73) hours, respectively. The mean number of patients under the care of nurses was 1.61 (0.40).
158 Also, the mean of nurses' work experiences was 8.14 (4.72) years and the mean weekly working
159 of them was 48.21 (8.59) hours.

160 Furthermore, 509 patients were under the care of nurses during the study period. The majority of
161 patients in this study were male (56.6%). The mean age of patients participating in the study was
162 48.85 (20.31) years, and the mean length of stay on ICU for all participants was 6.31 (5.51) days.
163 Most referrals to the ICU came from the operating theatre (52.3%) and emergency ward (34.6%).
164 Of this sample, 63.1% of patients needed surgery and 36.9% required medical treatment only.

165 The mean (SD) of the nursing workload in three shifts (morning, evening, night) was 72.84%
166 (22.07%). According to Table 2, there was a significant difference between the workload
167 experienced by nurses on different work shifts ($p = 0.001$). It was noted that there were significant
168 differences between the workload in morning shift in comparison with the evening shift (mean
169 difference (MD) = 10.85, $p = 0.002$) and night shift (MD = 13.37, $p = 0.001$). Male patients

170 produced a significantly higher workload for nurses ($p < 0.001$) in contrast to female patients.
171 Patients who received medical treatments caused a significantly higher workload for nurses than
172 patients who had received surgery ($p < 0.001$). Moreover, a statistically significant association was
173 identified between the nursing workload and patient referral sources ($p < 0.001$). Based on the post
174 hoc test, there was a significant difference between the patients admitted from the operating theatre
175 with patients admitted from the emergency ward (MD = -4.80, $p < 0.001$) and patients admitted
176 from other ICUs (MD = -7.99, $p = 0.02$).

177 Based on the multivariable linear regression analysis, a positive association was found between
178 nursing workload and female nurses ($b = 6.27$, 95% CI = 1.41, 11.13). Also, there was a direct
179 association between workload of nursing and number of patients under their care ($b = 25.04$, 95%
180 CI = 15.13, 34.96) and the length of patients' ICU stay ($b = 0.75$, 95% CI = 0.53, 0.97). Moreover,
181 an inverse relationship was seen between nursing workload and working in neurosurgical ICU (b
182 = -7.91, 95% CI = -12.91, -2.91), cardiac surgery ICU ($b = -14.58$, 95% CI = -20.87, -8.29),
183 obstetric ICU ($b = -31.91$, 95% CI = -39.15, -24.67), and burns ICU ($b = -31.18$, 95% CI = -41.22,
184 -21.14) (Table 2).

185 **4. DISCUSSION**

186 The purpose of this study was to determine the nursing workload in ICUs and investigate the
187 association between nursing workload and patients' and nurses' characteristics. In this study, the
188 mean NAS of the nursing workload was reported at 72.84%. The average nursing workload in
189 ICUs reported in other studies shows a wide variation (Esmaili et al., 2015). A study of
190 multidisciplinary ICUs in Norway showed that the nursing workload was 96.2% using the NAS
191 tool (Stafseth et al., 2011). The findings of a recent study conducted in Brazil revealed that the
192 nursing workload using the NAS in ICUs is lower at 63.5% (Strazzieri-Pulido et al., 2019). The

193 discrepancy of nursing workload in these studies could be due to different nurse staff frameworks
194 and organizations, differences in the types of patients admitted to ICUs and the technical and
195 practical differences in the use of the NAS tool (Stafseth et al., 2011, Strazzieri-Pulido et al., 2019,
196 Padilha et al., 2015).

197 To our knowledge, this study is one of the limited studies (Bruyneel et al., 2019, Debergh et al.,
198 2012) that evaluated the NAS for individual nurses across all three shifts. In comparison to
199 evaluating the NAS over 24 hours, evaluation using the NAS per shift can possibly provide better
200 data to determine a precise nurse-patient ratio. The findings of the current study indicated that ICU
201 nurses experience a higher workload in the morning shift than in the evening and night shifts.,
202 despite having a higher number of nurses in the morning shift (Ducci et al., 2008). Most patient
203 admissions, patients discharges, patient treatment procedures and follow-up administration are
204 performed during the morning shift (Armstrong et al., 2015). In addition, the number of nurses
205 does not decrease significantly in evening and night shifts in ICUs despite the possibility of new
206 patient admissions or the deterioration of patients' conditions (Debergh et al., 2012). Findings of
207 a study undertaken in 16 hospitals in Belgium demonstrated that ICU nurse workload in the
208 morning shift was considerably higher than evening and night shifts (Bruyneel et al., 2019).
209 Debergh et al.'s (2012) study also showed that workload in the night shift is lower than evening
210 and night shifts.

211 The results of the present study identified that male patients were associated with a higher
212 workload for ICU nurses. Similarly, findings of another study also showed that male trauma
213 patients in ICUs create a higher workload for nurses (Nogueira et al., 2014). Two other studies
214 also found a positive association between male patients and increased nursing workload in ICUs
215 (Padilha et al., 2008, Samuelsson et al., 2015). Although evidence is currently limited, it has been

216 suggested by some previous studies that male patients are more likely to be hospitalized in ICUs
217 and as a result of severe injuries, are likely to receive aggressive life support (Mahmood et al.,
218 2012, Fowler et al., 2009).

219 In our study, patients admitted with specific medical diagnoses ' were associated with a higher
220 workload than surgical admissions. In addition, there was a direct association between having a
221 higher nursing workload for nurses working in general ICUs. Similarly, Padilha et al.'s (2007)
222 study results highlighted that nursing workload in general ICUs was higher than surgical and burn
223 ICUs. Lucchini et al. (2015) used the NAS to evaluate nursing workload on ICUs and found
224 general ICUs in contrast with surgical ICUs imposed a higher workload for nurses. The higher
225 nursing workload of general ICUs may be due to the increased complexity and intensity of patient
226 care such as the need for hygiene procedures, mobilization, and positioning (Reich et al., 2015,
227 Lucchini et al., 2015). Furthermore, Padilha et al. (2008) documented that patients receiving
228 medical treatments in comparison with those who have had surgery created a higher nursing
229 workload in ICUs. Although according to our data, the type of patients' treatments and type of
230 ICU can be considered one of the factors that may influence the workload of nursing in different
231 ICUs, the previous studies have demonstrated that the intensity of the patient's condition more
232 important predictor of nursing workload in clinical practice (Altafin et al., 2014, Nogueira et al.,
233 2014, Romano et al., 2019). For instance, Altafin et al. (2014) found patients who died required a
234 higher workload for ICU nurses than those who survived.

235 In our study, a significant association was identified between nursing workload and patient referral
236 source. The referral sources of ICU patients can help predict nursing workload (Padilha et al.,
237 2008). Consistent with our results, another study found that the mean percentage NAS for patients
238 admitted from the emergency department was higher than for those admitted from the operating

239 theatre and general ward (Armstrong et al., 2015). However, this study also reported that the
240 workload of patients who were admitted from other ICUs was not high which is in conflict with
241 our results (Armstrong et al., 2015). Romano et al. (2019) in their study concluded the type of
242 admission to ICUs provides no valuable guidance to predict the required nursing workload for
243 patient care. This is inconsistent with our study and other published studies (Coelho et al., 2011,
244 Padilha et al., 2008).

245 Our study found a direct association between nursing workload and the number of patients under
246 the care of nurses which would be expected. Similarly, previous studies also showed a significant
247 relationship between the number of patients and the nursing workload (Penz et al., 2007, Coventry
248 et al., 2015). In fact, when the number of patients increase, the responsibility of nurses and the
249 time spent on direct patient care increases (Yusefi et al., 2019, Hugonnet et al., 2004, Halwani et
250 al., 2006).

251 We showed that there was a direct association between the patients' length of stay on ICU and
252 nursing workload. The relationship between NAS and length of ICU stay in the literature is
253 conflicting. Consistent with our findings, Padilha et al. (2008) reported that patients who remain
254 longer in the ICUs, for each extra ICU-day, have a 7.0% more probability of increasing the NAS.
255 Lucchini et al. (2014) during a five-year study with 5856 patients found the NAS was high in
256 patients with the increasing length of ICU stay. However, findings of another study revealed that
257 the NAS decreased with increasing patient length of stay in the ICU (Altafin et al., 2014).

258 In the present study, we found a direct association between the nursing workload and female
259 nurses. Consistent with our findings, Hoonakker et al. (2011) and Mirzaei et al. (2015) found
260 female nurses in ICUs experienced a higher workload. Female nurses may, in addition to the
261 stressful work environment in ICU face personal stressors including daily housework, parenting,

262 and childcare demands, and challenges to the work-life balance that lead to perceived high
263 workload and burnout (Papazian et al., 2018).

264 **4.1. Implications and Recommendations for Practice**

265 Our study extends the previous knowledge about nursing workload in ICUs and their related
266 factors. The findings of this study can be used by nursing and hospital managers to provide an
267 appropriate allocation of nursing staff on ICUs with additional consideration given to nurse and
268 patient characteristics, and can therefore improve the quality of care in ICUs. However, nurse and
269 patient characteristics should not be considered as the only predictive factors of nursing workload
270 in ICUs.

271 **4.2. Strengths and Limitations**

272 Our study investigated and measured the workload of each nurse in the morning, evening and
273 night shifts, therefore differing from the other studies cited in our literature review. Our study has
274 several limitations that should be considered. Firstly, a cross-sectional design was used in this
275 study; therefore, the results should not be considered causal. Secondly, this study was conducted
276 in Iran, which possibly decreases the generalizability of the results to other countries. Thirdly, the
277 NAS tool was originally developed to be applied over a 24-hour period. Although Debergh et al.
278 (Debergh et al., 2012) demonstrated that it could be used per shift, it seems that using this tool per
279 shift requires further validation in larger studies. Fourthly, although the results showed a
280 significant association between workload and nursing gender, this finding may be due to a greatly
281 uneven number of male nurses in our sample. Finally, the data for this study were collected about
282 4 years ago which could generate bias.

283 **Conclusion**

284 Our study shows that the nursing workload in ICUs was associated with both nurse and patient
285 characteristics. Type of work shifts, nurse gender, type of ICU which the nurses worked in, the
286 number of patients under a nurse's care, patient gender, medical or surgical treatment for patient,
287 patient referral source, and the length of patient ICU stay influenced nursing workload. Future
288 research should focus on gathering more clinical patient data in order to extend our study findings
289 regarding the relationship between nursing workload, patient characteristics and nurse
290 characteristics.

291 **Impact**

292 **WHAT IS KNOWN ABOUT THIS TOPIC**

- 293 • Some of the previous studies about nursing workload in an ICU and the associations with
294 nurse and patient characteristics present conflicting outcomes.

295 **WHAT THIS PAPER ADDS**

- 296 • Type of work shifts, nurse gender, type of ICU which nurses work in and the number of
297 patients under care were nurse characteristics that influenced workload.

298 Patient gender, patient ICU requirements, patient referral source, the length of patient ICU stay
299 were patient characteristics that influenced nursing workload.

300

301

302

303 **Table 1.** Comparison of nursing workload according to work shift, patient gender, patient treatment
 304 types, and patient referral sources

Variables		Workload Mean (SD)	Test	p-value
Work shift (workload per shift)	morning	81.46 (25.94)	F-value = 6.94	0.001*
	evening	70.61 (26.01)		
	night	68.09 (23.17)		
Patient gender (workload per patient)	male	47.78 (12.23)	t-value = 5.77 Df = 507	< 0.001**
	female	41.55 (11.85)		
Patient treatment types (workload per patient)	surgical	42.89 (11.04)	t-value= 5.30 Df = 507	< 0.001**
	medical	48.80 (13.79)		
Patient referral sources (workload per patient)	Operation theatre	42.93 (11.16)	F-value = 6.42	< 0.001*
	Emergency ward	47.73 (10.36)		
	General wards	45.57 (9.97)		
	Other ICUs	50.92 (41.04)		

* One-Way ANOVA

** Independent samples t-test

Df : degree of freedom.

305

306 Table 2. Association between nursing mean workload with individual and occupational characteristics of
 307 ICU nurses and their patients' characteristics

Nurses characteristics	b*	SE**	95% CI***	p-value
Female	6.27	3.96	1.41, 11.13	0.01
Age (ref # to < 30)				
30-40	2.59	2.93	-3.16, 8.35	0.37
> 40	2.78	7.44	-11.81, 17.37	0.70
Married	-2.98	1.86	-6.62, 0.66	0.10
Educational level (ref to Bachelor)				
Master	0.20	3.73	-7.10, 7.51	0.95
Work experience	0.42	0.34	-0.24, 1.09	0.21
Weekly working hours	0.31	0.11	-0.12, 0.74	0.08
Being employed at the other health care centers	3.02	2.46	-1.80, 7.84	0.21
Resting before the work shift	0.18	0.07	-0.07, 0.43	0.07
Resting after the work shift	0.01	0.07	-0.13, 0.16	0.83
Number of patients under care	25.04	5.05	15.13, 34.96	< 0.001
Type of ICU (ref # to General ICUs)				
Neurosurgical	-7.91	2.55	-12.91, -2.91	0.002
Cardiac surgery	-14.58	3.20	-20.87, -8.29	< 0.001
Obstetric surgery	-31.91	3.69	-39.15, -24.67	< 0.001
Burn	-31.18	5.12	-41.22, -21.14	< 0.001
Patients characteristics				
Age of patients	-0.02	0.12	-0.26, 0.21	0.82
Length of ICU stay	0.75	0.23	0.53, 0.97	0.02

* b coefficient was obtained according to the multivariable linear regression
 ** Standard error
 *** Confidence interval
 # Reference group

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