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## Nurses' Knowledge, Practice, and their Associated Factors regarding Perioperative Hypothermia Prevention at Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia

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3 1 **Nurses' Knowledge, Practice, and their Associated Factors regarding Perioperative**  
4 **Hypothermia Prevention at Northwest Amhara Regional State Referral Hospitals,**  
5 **Northwest Ethiopia**  
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7  
8

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42  
43 21 **Word count:** 4,745 (Introduction to conclusion; excluding tables and figure). The number of  
44 words exceeds 4000 because of further elaboration of the study setting.  
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## 28 **Abstract**

29 **Introduction:** Hypothermia is a health problem that is characterized as a body temperature below  
30 36 °c (96.8°F) and it is a common problem associated with perioperative patients, which can cause  
31 decelerates all physiologic roles. Therefore, nurses must strive to ensure normothermia for all  
32 patients.

33 **Objectives:** To assess nurses' knowledge, practices, and associated factors toward perioperative  
34 hypothermia prevention at Northwest Amhara Regional State Referral Hospitals, Northwest  
35 Ethiopia.

36 **Method:** Institution-based cross-sectional study was conducted to collect data from 423 nurses  
37 working in perioperative units by using stratified sampling technique. The collected data were  
38 checked for any inconsistency, coded and entered by using EPI INFO version 7, and analyzed by  
39 using SPSS version 25. To identify factors for dependent variables, bivariate and multivariate  
40 logistic regression models were fitted. Model fitness was checked using the Hosmer Lemeshow  
41 goodness of fit test.

42 **Results:** A total of 244 (59.1%) of the respondents had good knowledge and 208 (50.4%) had  
43 good practice in perioperative hypothermia prevention. Factors affecting nurses' knowledge on  
44 prevention of perioperative hypothermia were being male [AOR = 1.61,95% CI (1.02-2.53)],  
45 having a bachelor, and master's degree [AOR = 2.50; 95% CI (1.25-5.00), and 4.39; (1.45-13.20)]  
46 respectively, and took training [AOR = 3.68; 95% CI (2.14-6.33)]. Whereas nurses who were  
47 working in recovery and intensive care units [AOR = 2.87; 95% CI (1.08-7.58), and 2.39; 95% CI  
48 (1.09-5.22)] respectively, took training [AOR = 2.64; 95% CI (1.53-4.57)], had a Job satisfaction  
49 [AOR 2.15; 95% CI (1.34-3.43)], and knowledgeable nurses [AOR 2.64; 95% CI (1.63-4.27)] were  
50 factors affecting nurse's practice on perioperative hypothermia prevention.

51 **Conclusion and recommendation:** Nurses' knowledge and practice regarding prevention of  
52 perioperative hypothermia were found to be inadequate. So, it is better to strengthen training,  
53 educational opportunity, equip wards with standardized guidelines and materials, and motivate and  
54 create a safe working environment.

55  
56 **Keywords:** Perioperative hypothermia, Ethiopia, Knowledge, Practice, Nurses.

## 57 **Limitations and Strength of the study**

- 58     ▪ Due to the time constraint, observational data collection method was not done.
  - 59     ▪ Furthermore, this study was not triangulated with the qualitative method
  - 60     ▪ Due to the limited availability of literature, I have used unpublished sources.
- 61 ✓ Despite these limitations, this study clearly showed nurses' knowledge, practice, and associated  
62 factors toward perioperative hypothermia prevention for the first time in Ethiopia.

## 63 **Background**

64 Hypothermia is a common health problem in patients having surgery, that is characterized as a  
65 body temperature below 36 °c (96.8°F) and it is usually caused by too much heat loss from cold  
66 weather exposure, anesthetic effect, and administration of cold intravenous, or irrigation fluids (1-  
67 3). Hypothermia decelerates all physiologic roles including metabolic rate, mental awareness,  
68 nerve conduction, neuromuscular reaction times, and both the cardiovascular and respiratory  
69 systems, consequently disturbing patients' comfort and leading to longer hospitalizations, higher  
70 costs, and increased mortality (1, 4).

71 Different studies conducted in different areas revealed that the incidence of perioperative  
72 hypothermia in Germany, about 25%–90% (5), in brazil 69.8% (6), and in china ranged from  
73 44.3% to 72.7% (7, 8). And also in Ethiopia, the study conducted in Tikur Anbessa Specialized  
74 Hospital the overall magnitude of preoperative, intraoperative, and postoperative hypothermia  
75 were 16.2%, 53.2%, and 31.3%, respectively (9) while, in UoGCSRH the incidence of Pre, Intra,  
76 and post-operative hypothermia were 23.4%, 49.7%, and 50.6% respectively (10).

77 According to the Association of Perioperative Register Nurses (AORN) Guideline, nurses need to  
78 have knowledge and skill on hypothermia prevention at the perioperative phase. This includes  
79 measuring the patient's body temperature, selecting methods for prevention of unintended  
80 hypothermia, and implementing the selected insulation and warming interventions (11). Warming  
81 intervention measures include warming the patient before surgery ("pre-warming"), during  
82 surgery, and after surgery by using passive insulation methods include warmed cotton blankets,  
83 surgical draping and thermal garments, and by using active warming techniques include forced-air  
84 warming devices, electric warming blankets, and warmed fluids including blood products and  
85 using irrigation solutions and gases (12, 13).

1  
2  
3 86 Preventing heat loss and maintaining normothermia are important nursing care in an early phase  
4  
5 87 of resuscitation as metabolic changes accompanied by injury cannot be corrected when patients  
6  
7 88 are in hypothermic status (14). Nurses need to be cognizant of the risks associated with each  
8  
9 89 perioperative phase of the patient in the prevention of hypothermia(15). Preserving a normal body  
10  
11 90 temperature during the surgical experience enhances the patient's chance of preventing  
12  
13 91 postoperative complications (16).

14  
15 92 Different evidence reported that the maintenance of normothermia decreases the length of  
16  
17 93 hospitalization by approximately up to 40%, risk of surgical site infection by 64%, may prevent  
18  
19 94 the costs of potential stay in the intensive care unit by \$1,000 and a prolonged hospital stay by  
20  
21 95 \$465 per day, and also decreasing mortality rate by four folds (17-19). But available literature  
22  
23 96 shows that nurses' knowledge and practice towards perioperative hypothermia prevention is low  
24  
25 97 despite the high incidence, serious consequences, and availability of effective interventions to  
26  
27 98 prevent and treat this frequent surgical complication (2, 20).

28  
29 99 If nurses had not adequate knowledge and skill on the prevention of perioperative hypothermia, its  
30  
31 100 occurrence is inevitable. Even if nurses knowledge and practice are important in prevention of  
32  
33 101 perioperative hypothermia and its complication, available literature revealed that nurses had  
34  
35 102 significant knowledge and practice gaps (30). Different socio-demographic and institutional  
36  
37 103 factors which include age, marital status, educational level, work experience, presence of  
38  
39 104 guidelines and risk assessment protocol, taking training, reading updated evidence, and job  
40  
41 105 satisfaction affect nurses' knowledge and practice (2, 20-22).

42  
43 106 In Ethiopia, there are no studies is available regarding nurses' knowledge and practice on  
44  
45 107 perioperative hypothermia prevention. Therefore, the purpose of this study is to assess nurses'  
46  
47 108 knowledge, practice, and their determinant factors of perioperative hypothermia prevention in  
48  
49 109 Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia.

## 50 51 110 **Methods**

### 52 53 111 **Study design and period**

54  
55 112 Institutional based cross-sectional study was conducted in perioperative units/wards of five referral  
56  
57 113 hospitals from March 25-May 20/2021.

## 114 Study area

115 The study was conducted in Northwest Amhara Regional State Referral Hospitals, Northwest  
116 Ethiopia. Northwest Amhara is found in the northwestern part of Ethiopia. There are five  
117 government referral hospitals in Northwest Amhara regional state such as University of Gondar  
118 Comprehensive Specialized Referral Hospital (UoGCSRH), Felegehiwot Referral Hospital  
119 (FHRH), Tibebeqion Specialized Referral Hospital (TGSRH), Debre Markos Referral Hospital  
120 (DMRH), and Debre Tabor Comprehensive Referral Hospital (DTCRH). All hospitals provide  
121 outpatient and inpatient services for more than 22,000,000 million people living in their catchment  
122 area. According to information obtained from the administrative offices of these hospitals, there  
123 are 1682 nurses, who provide services. Among those 725 nurses are working in an emergency  
124 ward including trauma unit, operation room, recovery ward, surgical ward, orthopedics ward, and  
125 surgical ICU (42-46).

126 UoGCSRH is a teaching hospital, which is located in Gondar town. Gondar is the capital city of  
127 the central Gondar zone and is the famous historical town in northwest Ethiopia with latitude and  
128 longitude locations of 120 3'N and 370 28'E respectively. It is 748 km away from Addis Abeba  
129 and 173 km from Bahir Dar. Gondar town has one governmental hospital, eight health centers, and  
130 other private health facilities which provide health care service to the community. UoGCSRH was  
131 established in 1954 and provide serves approximately 7 million people. According to the hospital  
132 human resource administration report in 2021, the hospital has 595 nurse staff among those 153  
133 nurses who are working in a surgical emergency (including trauma), operation room, recovery  
134 ward, surgical ward, orthopedics ward, and also surgical ICU (42).

135 DMRH is located 299km from Addis Abeba and 265km from Bahir Dar. Its geographical location  
136 is 10° 11' N latitude and 37° 43' E longitude. The town has one governmental hospital and four  
137 health centers. DMRH potentially serves more than 5,000,000 people of the East Gojjam zone.  
138 According to the hospital human resource administration report in 2021, the hospital has 221 nurse  
139 staff among those 127 nurses who are working in emergency, operation room, recovery ward,  
140 surgical ward, orthopedics ward, and also surgical ICU (43).

141 DTCRH is located in the Debre Tabor town of the South Gondar zone of the Amhara region,  
142 654km far from the Northcentral of Addis Abeba, which is the capital city of Ethiopia, and 108km  
143 to the east of Bahir Dar. The town has a latitude and longitude of 11°51' N38°1'E with an elevation



1  
2  
3 144 of 2,706m above sea level. Debre Tabor referral hospital provides health care services for more  
4  
5 145 than 2 million populations. According to the hospital human resource administration report in  
6  
7 146 2021, the hospital has 156 nurses staff among those 81 nurses who are working in emergency,  
8  
9 147 operation room, recovery ward, surgical ward, orthopedics ward, and also ICU ward (44).

10  
11 148 FHRH is located in Bahir Dar the capital city of Amhara region. The city is located approximately  
12  
13 149 565km northwest of Addis Abeba having a latitude of 11° 38' North, a longitude of 37°15' east,  
14  
15 150 and elevation 1840 above sea level. Bahir Dar city has three governmental hospitals and nine health  
16  
17 151 centers. In addition, there are also private health facilities (including hospitals and higher clinics)  
18  
19 152 that provide health care services to the community. According to the hospital human resource  
20  
21 153 administration report in 2021, Felegehiwot referral hospital has 430 nurse staffs among those 220  
22  
23 154 nurses who are working in emergency, operation room, recovery ward, surgical ward, orthopedics  
24  
25 155 ward, and also surgical ICU ward (45).

26  
27 156 TGSRH is a new hospital and located on the outskirts of the vibrant Bahir Dar city (one of the ten most  
28  
29 157 beautiful cities in Africa and one of the twelve UNESCO Learning Cities Awardees of 2015). It also  
30  
31 158 far about 10km south of the city center and about 7 km from the new bus station (Addisu Meneharia)  
32  
33 159 on the way to Adet district and about 23 km from the Blue Nile Falls. According to the hospital human  
34  
35 160 resource administration report in 2021, the hospital has 280 nurse staff among those 144 nurses  
36  
37 161 who are working in emergency, operation room, recovery ward, surgical ward, orthopedics ward,  
38  
39 162 and also surgical ICU ward (46).

### 163 **Source population**

40 164 Source populations were all nurses who were working in emergency, operation room, recovery  
41  
42 165 ward, surgical ward, orthopedics ward, and surgical ICU ward of Northwest Amhara Regional  
43  
44 166 State Referral Hospitals, Northwest Ethiopia.

### 167 **Study population**

47 168 The study population included nurses who were working in emergency ward including trauma  
48  
49 169 unit, operation room, recovery ward, surgical ward, orthopedics ward, and surgical ICU wards of  
50  
51 170 UoGCSRH, DTCRH, DMRH, TGRH, and FHRH during the data collection period.

### 171 **Sample size and sampling procedure**

## 172 **Sample size**

173 The sample size of the study was calculated using the formula for the estimation of a single  
174 population proportion and the assumptions were the proportion of knowledge and practice of  
175 nurses regarding hypothermia prevention was 50% (since there was no study conducted in our  
176 country), with 95% level of confidence and 5% margin of error. By using a z-value of 1.96 at 95%  
177 CI the minimum sample size for this study was:

$$178 \text{ As: } n = Z^2 \alpha / 2^2 * P (1-P) / d^2$$

179  $n$  = sample size

180  $p$  = proportion of knowledge & practice of nurses on hypothermia prevention =0.5

181  $d$  = maximum allowable error (margin of error) = 0.05

182  $Z$  = value of standard normal distribution at 95% confidence level ( $z=1.96$ ).

$$183 n = (1.96)^2 (0.5) (1-0.5) / (0.05)^2 = 384 \text{ subjects;}$$

184  $\Rightarrow$  By adding 10% allowance for non-response rate the total sample size were  $384+10\%=423$

## 185 **Sampling procedure**

186 The study was performed on nurses who were working at the emergency surgical (including  
187 trauma unit), operating theatre room, recovery ward, surgical ward, orthopedics ward, and surgical  
188 ICU ward of Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia. A  
189 stratified sampling technique was employed to recruit the required participant for the study. First,  
190 the study participants are stratified from each hospital and working ward/unit and allocated the  
191 required sample for each stratum proportionally. According to all hospitals of human resources,  
192 administration reports the total number of nurses who were working in these units or wards was  
193 725. Based on the number of nurses working in each hospital, 423 samples were proportionally  
194 allocated from 725 (from 153 - 89 in UoGCSRH, from 144 - 84 in TGRH, from 220 - 128 in FHRH,  
195 from 81 - 48 in DTRH, and 127 - 74 in DMRH). Finally, those participants were taken by lottery  
196 method of simple random sampling technique from each sampling frame (Figure 1).

## 197 **Eligibility criteria**

## 198 **Inclusion Criteria**

199 All nurses who were working in the surgical emergency, operating theatre room, recovery ward,  
200 surgical ICU, surgical & orthopedic ward of Northwest Amhara Regional State Referral Hospitals,  
201 Northwest Ethiopia during the time of data collection.

### 202 **Exclusion Criteria**

203 Matron and ward coordinator nurses were excluded because those nurses are primarily responsible  
204 is coordinating, monitoring, and evaluating the staff nurses rather they doing routine activities.

### 205 **Operational definitions**

206 **Knowledge:** Is theoretical or practical understanding of hypothermia and its prevention method  
207 through education or experience. Based on this research the percentage scores were graded as  
208 'poor', and 'good to determine the knowledge level.

209 **Good knowledge:** If the study participants answer the knowledge questions above or equal to the  
210 computed median were considered as having good knowledge.

211 **Poor knowledge:** If the study participants answer, the knowledge questions below the computed  
212 median were considered as having poor knowledge.

213 **Practice:** Activities acting by nurses to prevent hypothermia. Items in this category of the Likert  
214 scale were intended to determine the frequency of performing certain interventions to prevent  
215 hypothermia and to increase patient comfort. The response categories were coded as 0 to 2 for:  
216 never, sometimes, and always.

217 **Good practice:** The study participants who answer above or equal to the computed median of  
218 practice questions were considered as having good practice.

219 **Poor practice:** The study participants who answer below the computed median of practice  
220 questions were considered as having poor practice.

221 **Job satisfaction:** is a positive or pleasurable emotional state resulting from the appraisal of one's  
222 job or job experience. Job satisfaction of nurses was measured using the questionnaire adopted by  
223 the principal investigator with a 27-item scale. This instrument had 5-point Likert scales in which  
224 five denotes strongly Agree and one denotes strongly disagree. When the total score for the job  
225 satisfaction questionnaire was greater than or equal to the computed median, we said they were

226 satisfied, and less than the computed median, we said they were dissatisfied with the overall aspect  
227 of their work.

### 228 **Data collection instruments and procedure**

229 Data was collected by using a self-administered questionnaire which was adapted from guidelines  
230 of AORN and NICE perioperative hypothermia prevention, and other literature (which involves  
231 27 questions for knowledge and 14 questions for practice (20, 34, 47, 48), and 15 questions for  
232 Socio-demographic, institutional and other characteristics (2, 4, 20-22, 34, 39). The questioners  
233 were prepared in the English language based on the study objectives, focusing on the background  
234 information of hypothermia and its prevention. Five BSc nurse staff who were working other than  
235 the study ward were recruited for data collection and two MSc holder nurses were recruited as a  
236 supervisor. Overall, the data collection process was coordinate and supervise by the principal  
237 investigator.

### 238 **Data quality control**

239 To ensure the quality of data one-day training was given to data collectors and supervisors  
240 regarding the objective of the study and data collection process. Moreover, the questionnaire was  
241 pretested among 5% of the sample size (21 nurses) at Woldia Referral Hospital. Regular  
242 supervision was done to check the consistency and completeness of the filled-out questionnaires,  
243 by the supervisors and principal investigator. The reliability of the tool for each outcome variable  
244 and job satisfaction questionnaires were checked by using SPSS version 25, Cronbach's alpha  
245 reliability test. The tests were shows 0.81, 0.77, and 0.91 for knowledge, practice, and job  
246 satisfaction respectively, which is greater than the minimum standard (0.7). This shows that the  
247 tool was reliable in terms of internal consistency. To adhere to confidentiality, the names in the  
248 questionnaires were replaced by codes, and the participants were informed about these so that they  
249 had a record of their codes to facilitate tracking of the completeness of their respective  
250 questionnaires. The supervisors and the principal investigator were responsible for checking on  
251 the completeness of the data on-site. Incomplete questionnaires were put in offices arranged for  
252 this purpose so that participants completed their questionnaires. Furthermore, the supervisors and  
253 principal investigators throughout the data collection period did intensive supervision.

## 254 **Data processing and analysis**

255 After the data was checked for its consistency and completeness, data were entered into Epi Info  
256 version 7 and exported into SPSS version 25 for analysis. Descriptive analysis was done for each  
257 variable in the study by running frequencies, percentages, and median with IQR. Tables were used  
258 for presenting results to give a clear picture of the magnitude and relationships of various study  
259 variables. Binary logistic regression was used to determine the significant association between the  
260 independent and dependent variables. Those independent variables, which are less than 0.2 in  
261 bivariate analysis, were entered into multivariable logistic regressions. Association between the  
262 independent variable and dependent variable was considered significant if P-value was less than  
263 0.05 from multivariate logistic regression analysis. Multicollinearity was checked by using the  
264 variance inflation factor and its values were between 1 and 10. Model adequacy was checked by  
265 using Hosmer and Lemeshow so the model indicates a good fit which indicates .856 and .993 for  
266 knowledge and practice respectively.

## 267 **Patient and public involvement**

268 The questionnaires used for this study were developed or adapted from different literature and  
269 guidelines. The study focused on nurses' knowledge, practice, and determinant factors regarding  
270 perioperative hypothermia prevention at Northwest Amhara regional state referral hospitals.  
271 Because nurses are primarily responsible body to prevent the occurrence of hypothermia in  
272 surgical patients. So that nurses were actively involved, no patients or member of the public were  
273 involved in the design or planning of this research study. The result of the study will disseminate  
274 to hospital managers, regional health bureau, policymakers, and researchers in preparing plans,  
275 adopting practical guidelines, budget allocation for fulfilling materials and training, design proper  
276 strategies, and serve as baseline information's.

## 277 **Results**

### 278 **Socio-demographic characteristics of the respondents**

279 A total of 423, with a response rate of 97.6% of study participants were involved in this study. The  
280 median age (IQR) of the study participants was 29 (27, 32) years, ranging from 20-58 years and  
281 almost half of the participants were under the age category between 26 to 30 years. Two hundred

thirteen (51.6%) of the participants were male, and 235(56.9%) were married. Out of 413 nurses, three-fourth of the respondents had a bachelor's degree, and one hundred eighty-one (43.8%) of the respondents had 6-10 years of work experience. One hundred seventy-two (41.6%) of participants' monthly salary were range from 7001-9000 and the median salary of the respondents was 7071 with an interquartile range of (5644, 8017) Ethiopian birr (Table1).

Table 1: Sociodemographic characteristics of the study participants on hypothermia prevention among perioperative patients in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021(N=413).

Variable	Response	Frequency (N=413)	Percentage (%)
Sex	Male	213	51.6
	Female	200	48.4
Age	≤ 25 years	53	12.8
	26-30	224	54.2
	31-35	86	20.8
	≥ 35	50	12.1
Marital status	Single	163	39.5
	Married	235	56.9
	Divorced	12	2.9
	Widowed	3	.7
Educational status	Diploma	59	14.3
	Degree	311	75.3
	Master	43	10.4
Work experience	≤ 5 years	157	38
	6-10	181	43.8

Variable	Response	Frequency (N=413)	Percentage (%)
	11-15	57	13.8
	≥ 16	18	4.4
Monthly salary(ETB)	≤ 5000	42	10.2
	5001-7000	158	38.3
	7001-9000	172	41.6
	≥ 9001	41	9.9

290 *ETB- Ethiopian Birr*

### 291 **Institutional and job-related factors of the respondents**

292 From 413, 268(64.9%) of nurses did not take training about perioperative hypothermia prevention.  
 293 half of the respondents reports that they were reading or reviewing updated evidence, and only  
 294 121(29.3%) of participants have notified the presence of guidelines or protocols in their working  
 295 area. Out of the study participants, 268 (64.9%) and 342 (82.8%) were having a shortage of  
 296 thermometers and warming materials respectively. From 413 study participants near half of 217  
 297 (52.5%) participants were satisfied with their jobs (Table 2).

298 Table 2: Institutional and other related factors of the respondents on perioperative hypothermia  
 299 prevention in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021. (N=413).

Variable	Response	Frequency (N=413)	Percentage (%)
Working place (hospital)	TGSRH	84	20.3
	UoGCSRH	83	20.1
	DMCRH	73	17.7
	DTCRH	47	11.4
	FHRH	126	30.5

Variable	Response	Frequency (N=413)	Percentage (%)
Ward:	Emergency	103	24.9
	Recovery	39	9.4
	OR	102	24.7
	ICU	53	12.8
	Orthopedics ward	46	11.1
	Surgical ward	70	16.9
Daily working hours	≤ 8 hrs	354	85.7
	≥9 hrs	59	14.3
Training on hypothermia prevention	Yes	145	35.1
	No	268	64.9
Presence of protocol/guideline	Yes	121	29.3
	No	292	70.7
Reading updated evidence on hypothermia prevention	Yes	206	49.9
	No	207	50.1
Availability of thermometer	Yes	145	35.1
	No	268	64.9
Constraints of warming material	Yes	342	82.8
	No	71	17.2
Shortage of blanket	Yes	166	40.2
	No	247	59.8
Shortage of linens	Yes	89	21.5
	No	324	78.5



Variable	Response	Frequency (N=413)	Percentage (%)
Shortage of fluid warmer	Yes	132	32.0
	No	281	68.0
Shortage of air warmer/heater	Yes	212	51.3
	No	201	48.7
Shortage of warmer blanket	Yes	217	52.5
	No	196	47.5
Job satisfaction	Satisfied	217	52.5
	Dissatisfied	196	47.5

### 300 Knowledge of nurses on hypothermia prevention

301 The overall median knowledge score of the study participants on perioperative hypothermia  
 302 prevention was 18 with an IQR of (16, 21). In this study, 244 (59.1%) with 95% CI: (54.7, 63.7)  
 303 of the participants had good knowledge while the rest were not knowledgeable. Among a total of  
 304 knowledge assessment questions, 359(86.9%) and 288(69.7%) of participants have correctly  
 305 answered the statement of the internal environment of humans can be maintained by  
 306 thermoregulation, and perioperative hypothermia is characterized as a core body temperature of <  
 307 36 ° C respectively. Three-fourth of the participants gave the correct answer of anesthetic drugs  
 308 increase heat loss while 250(60.5) of the participants correctly answered the complications of  
 309 hypothermia in surgical patients. Only 83(20.1%) of the participants were correctly respond in the  
 310 theatre room, the patient's temperature should be measured every 30 minutes while in the recovery  
 311 room, every 15 minutes (Table 3).

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317 Table 3. Nurse's responses on knowledge of perioperative hypothermia prevention (N=413)

Statements about perioperative hypothermia prevention	True/ False	Correct answer		Wrong answer /I don't know	
		N	%	N	%
The internal environment of humans can be maintained by thermoregulation.	T*	359	86.9	54	13.1
PH at any time during the perioperative cycle is characterized as a core body temperature < 36 ° C.	T*	288	69.7	125	30.3
Anesthetic drugs decrease heat loss in surgical patients.	F**	311	75.3	102	24.7
Cold IV fluids and blood products increase heat loss.	T*	288	69.5	126	30.5
PH is not associated with complications such as changes in drug metabolism, healing complications, shivering, clotting defects, cardiac morbidity, and prolonged post-anesthetic recovery.	F**	250	60.5	163	39.5
To minimize post-operative complications, nurses should advise patients to bring along additional clothing to help them stay warm before surgery	T*	339	82.1	74	17.9
The pulmonary artery catheter, distal esophagus, urinary bladder, rectum, zero heat-flux are some of the sites for temperature measurements.	T*	174	42.1	239	57.9
Nurses should be well trained and knowledgeable about the use of both temperature recording and warming devices	T*	346	83.8	67	16.2
Forced-air warming devices, warm water circulating and conductive devices are not some of the devices for warming surgical patients	F**	241	58.4	172	41.6
The method for temperature monitoring should not be chosen based on the criteria for a procedure	F**	281	68	132	32
To ensure accurate information, the team takes the patient's temperature at 15-minute intervals using different measuring devices at different sites.	F**	138	33.4	275	66.6
Patients with temperature < 36.0°C undergoing anesthesia & those having a high risk of cardiovascular complications are at higher risk for IPH	T*	293	70.9	120	29.1
It is not necessary to measure patients' temperature in the hour before departing the ward since it will be measured at the theatre.	F**	279	67.6	134	32.4

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53	<p>Except in urgent circumstances, preoperative patients with temperatures of &lt; 36.0°C should be warmed for 30 minutes by using active warming method</p> <p>Special attention should be given to the comfort of surgical patients having difficulties expressing themselves</p> <p>The method for warming patients should be chosen based on planned procedure, patient position, IV access site, and warming equipment constraints.</p> <p>Critical incidence reporting is not necessary for patients coming into the theatre with a temperature of less than 36.0°C.</p> <p>Induction of anesthesia should not begin unless the patient's temperature is 36.0°C or above.</p> <p>The theatre's room temperature should be at least 21°C which can be adjusted to allow better working once active warming is initiated.</p> <p>All irrigation fluids used intraoperative should be warmed in a thermostatically controlled cabinet to a temperature of 38- 40°C.</p> <p>Fluid warming devices should be used to warm IV fluids (500mls or more) &amp; blood products to 37°C</p> <p>Regardless of the temperatures of patients before leaving the ward, they should be warmed using active warming method once in the theatre</p> <p>The surgical patient should be well covered throughout surgery to conserve heat and only be exposed during surgical preparation.</p> <p>During the post-operative period, hypothermic patients should be warmed using AWM until they become warm before transferring them to the ward.</p> <p>Patients should be provided with at least 1 cotton sheet, 2 blankets, or a duvet during the postoperative phase</p> <p>Whiles in the OR, the patients' temperature should be measured every 15 minutes and every 30 minutes while in the RR.</p> <p>The temperature of post-operative patients should be recorded on arrival in the ward and be documented as part of a routine 4 hrs. observations.</p>	<p>T*</p> <p>T*</p> <p>T*</p> <p>F**</p> <p>T*</p> <p>T*</p> <p>T*</p> <p>T*</p> <p>T*</p> <p>T*</p> <p>T*</p> <p>T*</p> <p>F**</p> <p>T*</p>	<p>284</p> <p>335</p> <p>333</p> <p>259</p> <p>203</p> <p>273</p> <p>214</p> <p>260</p> <p>256</p> <p>310</p> <p>348</p> <p>319</p> <p>83</p> <p>337</p>	<p>68.8</p> <p>81.1</p> <p>80.6</p> <p>62.7</p> <p>49.2</p> <p>66.1</p> <p>51.8</p> <p>63</p> <p>62</p> <p>75.1</p> <p>84.3</p> <p>77.2</p> <p>20.1</p> <p>81.6</p>	<p>129</p> <p>78</p> <p>80</p> <p>154</p> <p>210</p> <p>140</p> <p>199</p> <p>153</p> <p>157</p> <p>103</p> <p>65</p> <p>94</p> <p>330</p> <p>76</p>	<p>31.2</p> <p>18.9</p> <p>19.4</p> <p>37.3</p> <p>50.8</p> <p>33.9</p> <p>48.2</p> <p>37</p> <p>38</p> <p>24.9</p> <p>15.7</p> <p>22.8</p> <p>79.9</p> <p>18.4</p>
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318 T\*-True statement, F\*\*- False statement, N- Number of participants.

### 319 Practice of nurses on hypothermia prevention

320 The overall median practice score of the study participants on perioperative hypothermia  
 321 prevention was 18 with an IQR of (14, 21). In this study, 208 (50.4%) with 95% CI: (45.5, 55) of  
 322 the participants had a good practice. Among practice assessment questions, 258(62.5%) of the  
 323 respondents they measure temperature as soon as patient arrival and 224(54.2 %) of the  
 324 respondents were always assessing the sign and symptoms of hypothermia. Nearly half of the  
 325 respondents 217(52.1%), 214(51.8%), and 213(51.6%) were sometimes developed and  
 326 implemented care plans on perioperative hypothermia prevention, maintaining ambient room  
 327 temperature according to guidelines, and also applying warm intravenous, blood products, and  
 328 irrigation fluids respectively. Among 413 participants, 185(44.8%) of the respondents were  
 329 reported never using forced-air warming devices, warm water circulating devices, and conductive  
 330 devices for warming surgical patients (Table 4).

331 Table 4. Nurse's responses on the practice of perioperative hypothermia prevention in Northwest  
 332 Amhara Regional State Referral Hospitals, Northwest, Ethiopia (N=413)

Hypothermia prevention practices	Never		Some times		Always	
	N	%	N	%	N	%
Do you measure temperature as soon as patient arrival?	21	5.1	134	32.4	258	62.5
Do you measure temperature regularly according to guidelines?	50	12.1	202	48.9	161	39
Do you warm intravenous, blood products, and irrigation fluids using warming devices before administering to patients?	112	27.1	213	51.6	88	21.3
Do you cover the mattress plastic sheet with dry linen before patient admission?	59	14.3	200	48.4	154	37.3

Hypothermia prevention practices	Never		Some times		Always	
	N	%	N	%	N	%
Do you use forced-air warming devices, warm water circulating devices, and conductive devices for warming patients?	185	44.8	170	41.2	58	14
Do you communicate your assessment findings on factors that could lead to hypothermia to all members of the perioperative team?	57	13.8	160	38.7	196	47.5
Do you advise patients to inform you when they feel cold during their hospitalization?	53	12.8	195	47.2	165	40
Do you develop and implement care plans for perioperative hypothermia prevention?	73	17.7	217	52.5	123	29.8
Do you document the site for temperature measurement in the patients' file?	63	15.3	156	37.8	194	47
Do you maintain ambient room temperature according to the guideline?	110	26.6	214	51.8	89	21.5
Do you assess patients for their risk for perioperative hypothermia?	41	9.9	202	48.9	170	41.2
Do you assess for signs and symptoms of hypothermia?	30	7.3	159	38.5	224	54.2
Do you advise patients to stay warm prior to surgery?	48	11.6	185	44.8	180	43.6

Hypothermia prevention practices	Never		Some times		Always	
	N	%	N	%	N	%
Do you include thermoregulation interventions and patient-related care to thermoregulation in your hand-over report	41	9.9	194	47	178	43.1

### 333 Factors associated with the level of knowledge on hypothermia prevention

334 In the binary logistic regression, ten from fifteen variables were found to have a significant  
 335 association with participants' level of knowledge on hypothermia at a p-value of < 0.2. However,  
 336 after controlling for the effects of potentially confounding variables using multivariate logistic  
 337 regression only sex, educational status, and training were found to be significant predictors for  
 338 knowledge on hypothermia prevention.

339 In this study, being male had 1.61 times more knowledge [AOR = 1.61,95% CI (1.02-2.53)]. Study  
 340 participants who had an educational level of degree and masters were 2.5 and 4.39 times more  
 341 likely to have good knowledge [AOR = 2.50; 95% CI (1.25-5.00), 4.39; (1.45-13.20)] respectively.  
 342 In this study also nurses who took training on perioperative hypothermia prevention had 3.68 times  
 343 more knowledge [AOR = 3.68; 95% CI (2.14-6.33)] (Table 5).

344 Table 5- Bi-variable and multivariable analysis of factors associated with knowledge of nurses on  
 345 perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia.

Variable	Knowledge of nurses		COR (95%CI)	P-value	AOR (95% CI)	P-value
	Good	Poor				
Sex						
Female	105	95	1		1	
Male	139	74	1.69(1.14-2.52)	.009	1.61(1.02-2.53)	.038**
Educational status						
Diploma	19	40	1		1	

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Degree	191	120	3.35(1.85-6.05)	.000	2.50(1.25-5.00)	.010**
Master	34	9	7.95(3.18-19.8)	.000	4.39(1.45-13.2)	.008**
Hospital						
FHRH	67	59	1		1	
UoGCSRH	48	35	1.20(.69-2.11)	.314	1.18(.631-2.21)	.601
DMCRH	51	22	2.04(1.11-3.76)	.056	1.74(.863-3.49)	.118
DTCRH	33	14	2.08(1.01-4.25)	.046	2.16(.933-4.94)	.068
TGSRH	45	39	1.01(.58-1.77)	.955	1.20(.627-2.29)	.581
Ward						
Emergency	52	51	1		1	
Recovery	31	8	3.8(1.59-9.05)	.003	2.24(.862-5.84)	.098
ICU	34	19	1.75(.88-3.46)	.106	1.48(.696-3.16)	.307
OR	67	35	1.87(1.07-3.29)	.028	1.51(.799-2.86)	.203
Orthopedics	26	20	1.27(.63-2.56)	.496	1.35(.641-3.02)	.402
Surgical	34	36	.92(.50-1.70)	.805	.850(.431-1.67)	.640
Monthly salary(ETB)						
≤ 5000	18	21	1		1	
5001-7000	90	74	1.41(.7-2.85)	.477	1.10 (.478-2.35)	.885
7001-9000	107	64	1.95(.96-3.93)	.075	.848(.492-2.49)	.802
≥ 9001	29	10	3.38(1.3-8.79)	.010	1.53(.507-4.67)	.447
Having guideline						
No	124	168	1		1	
Yes	75	46	1.37(.88-2.1)	.153	.848(.490-1.46)	.555
Took Training						

No	128	140	1		1	
Yes	116	29	4.37(2.72-7.01)	.000	3.68(2.14-6.33)	.000**
Reading updated evidence						
No	106	100	1		1	
Yes	138	69	1.88(1.26-2.80)	.002	1.32(.834-2.10)	.234
Shortage of thermometer						
Yes	148	120	1		1	
No	96	49	1.58(1.04-2.41)	.031	1.27(.776-2.08)	.325
Job satisfaction						
Unsatisfied	100	95	1		1	
Satisfied	144	74	1.84(1.24-2.74)	.002	1.38(.873-2.20)	.166

Variables which show significant association during multivariable logistic regression at \*\*p-value <0.05, Hosmer and Lemeshow test P=.856, 1=Reference.

### Factors associated with the level of practice on hypothermia prevention

In bivariate logistic regression analysis, eleven from sixteen variables were found to have significant predictors at a p-value < 0.2. But after controlling for the effects of potentially confounding variables using multivariate logistic regression only nurses working ward, took training, job satisfaction, and knowledge of nurses were found to be significant predictors for the practice of nurses on hypothermia prevention at (P<0.05).

Nurses who were working in recovery and intensive care units were 2.87 and 2.39 times more likely to have good practice [AOR = 2.87; 95% CI (1.08-7.58), and 2.39; 95% CI (1.09-5.22)] respectively. Nurses who took training in hypothermia prevention were 2.64 times more likely to have good practices for hypothermia prevention [AOR = 2.64; 95% CI (1.53-4.57)]. In this study, also nurses who are satisfied with their job were 2.15 times higher to have a good level of practice [AOR 2.15; 95% CI (1.34-3.43)]. The other significant variable is nurses who had knowledge of



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3 360 hypothermia were 2.64 times higher to have a good level of practice [AOR 2.64; 95% CI (1.63-  
4 361 4.27)] (Table 6)

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6  
7 362 Table 6- Bi-variable and multivariable analysis of factors associated with the practice of nurses on  
8 363 perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia.

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For peer review only

Variable	Practice of nurses		COR (95%CI)	P-value	AOR (95% CI)	P-value
	Good	Poor				
Educational status						
Diploma	16	43	1		1	
Degree	159	152	2.81(1.51-5.20)	.000	1.94(.902-4.20)	.089
Master	24	19	3.39(1.47-7.79)	.002	1.28(.411-4.00)	.669
Working ward						
Emergency	41	62	1		1	
Recovery	30	9	5.04(2.1-11.71)	.000	2.87(1.08-7.58)	.033**
ICU	34	19	2.70(1.36-5.37)	.004	2.39(1.09-5.22)	.029**
OR	59	43	2.07(1.18-3.62)	.010	1.63(.856-3.12)	.136
Orthopedics	20	26	1.16(.575-2.35)	.674	1.17(.527-2.62)	.693
Surgical	24	46	.78(.419-1.48)	.467	.657(.321-1.34)	.250
Work experience						
≤ 5 years	69	88	1		1	
6-10	95	86	1.4(.917-2.16)	.118	1.26(.713-2.23)	.424
11-15	32	25	1.63(.886-3.00)	.116	1.68(.735-3.86)	.217
≥ 16	12	6	2.55(.911-7.14)	.075	3.26(.85-12.44)	.083

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Monthly salary(ETB)							
≤ 5000	17	25	1			1	
5001-7000	67	91	1.08(.542-2.16)	.822		1.01(.436-2.35)	.976
7001-9000	98	74	1.94(.987-3.86)	.057		1.26(.517-3.10)	.604
≥ 9001	26	15	2.54(1.05-6.17)	.038		1.05(.310-3.58)	.933
Having guideline/ protocol							
No	131	161	1			1	
Yes	77	44	2.15(1.39-3.32)	.001		1.42(.824-2.47)	.205
Took training							
No	104	164	1			1	
Yes	104	41	4.00(2.58-6.19)	.000		2.64(1.53-4.57)	.001**
Reading updated evidence							
No	84	122	1			1	
Yes	124	83	2.17(1.46-3.21)	.000		1.37(.853-2.21)	.192
Constraint of thermometer							
Yes	123	145	1.67(1.11-2.51)	.014		1.10(.661-1.83)	.711
No	85	60	1			1	
Shortage of warming material							
Yes	166	176	1.53(.914-2.57)	.105		1.77(.923-3.39)	.086
No	42	29	1			1	
Job satisfaction							
Unsatisfied	71	124	1			1	
Satisfied	137	81	2.95(1.97-4.41)	.000		2.15(1.34-3.43)	.001**
Knowledge							

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Good	157	87	4.17(2.74-6.35)	.000	2.64(1.63-4.27)	.000**
Poor	51	118	1		1	

366 Variables which show significant association during multivariable logistic regression at\*\* p-value  
 367 <0.05, Hosmer and Lemeshow test P=.993, 1=Reference.

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## 370 Discussion

371 The result of this study showed that the overall knowledge of nurses on perioperative hypothermia  
 372 prevention was 59.1% with 95% CI (54.7, 63.7). This finding is higher than previous studies  
 373 conducted at AaBET hospital in Addis Ababa, Ethiopia (52.1%) (30). The possible reason might be  
 374 due to sociodemographic differences, in the previous study most participants were having a degree  
 375 and diploma level of educational status and the study area was a single setting of trauma center  
 376 while in the current study greater than 10% of the participants had masters and study settings were  
 377 multicenter. The other reason might be due to the difference in the time of the study because of  
 378 the advancement of technology including updated evidence, educational programs were increased  
 379 when the time is more and more recent. So, the participants might have to get more information  
 380 regarding the topics. But this finding is much lower than those of studies conducted in Gambia  
 381 (82%) (20), Turkey (77.5%) (4), Brazil (81.5%) (24), University of Iowa Hospitals and Clinics,  
 382 America (71%) (25), Maryland, America (100%) (26), Ireland (28), and also as compared to NICE,  
 383 AORN, and ASPAN guidelines of perioperative hypothermia prevention (3, 11, 23). The possible  
 384 justification for this difference might be due to the level of staff training, adopted recommended  
 385 guidelines, socioeconomic status, and sample size. According to training on hypothermia  
 386 prevention in this study, only a few nurses (35.1%) have been trained while in the comparison  
 387 group except in Gambia, almost all participants were taking training on perioperative hypothermia  
 388 prevention. In terms of using guideline/protocol, the studies conducted in America participants  
 389 always used recommended guidelines and protocols while in this study only 29.3% of nurses were  
 390 report having guidelines/protocols. According to difference in socioeconomic status of the  
 391 participants as well as study setting, we Ethiopians are under a low-income country compared to  
 392 America, Brazil, Ireland. This indirectly affects the quality of healthcare education as well as

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3 393 healthcare setting. In terms of sample size in the present study has a larger sample size (n=413) as  
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5 394 compare to all listed above (in Gambia (n=53), Turkey(n=200), Brazil(n=21), University of Iowa  
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7 395 Hospitals and Clinics, America n=30, Maryland, America n=19, Ireland n=198).

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9 396 In this study, the overall practice of nurses on perioperative hypothermia prevention was 50.4%  
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11 397 with 95% CI (45.5-55). This is consistent with the studies done in AaBET hospital Addis Abeba,  
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13 398 Ethiopia (52.5%)(30), and Durban, South Africa (46%)(35). But this study is higher than the study  
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15 399 done in Gambia (19%)(20). The possible reason might be the difference in socio-demographic  
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17 400 characteristics like most of the participants in the Gambia were have less than five years'  
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19 401 experience, and hadn't masters holder participants. On the other hand, the result of this study is  
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21 402 much lower when from NICE, AORN, and ASPAN recommendations guidelines (3, 11, 23). This  
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23 403 discrepancy could be due to the insufficient availability of warming material, measurement  
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25 404 material, and guidelines or protocol. Might be also an inadequate opportunity for frequent training  
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27 405 for nurses.

28 406 Regarding the determinants of the level of knowledge on hypothermia prevention, this study has  
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30 407 found out that male nurses were found to have more knowledge with hypothermia prevention by 1.6  
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32 408 times as compared to females. The reason might be females have an extra workload, most home  
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34 409 activities such as bearing and taking care of children, cooking, washing e.t.c, are mostly done by  
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36 410 females (49). So due to being overloaded by other additional home activities they might haven't  
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38 411 enough time to scale up their knowledge.

39 412 Nurses who had degrees and masters were more likely to have good knowledge with hypothermia  
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41 413 prevention by 2.5 and 4.4 times respectively as compared to those who had a diploma. This finding  
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43 414 is supported by studies conducted in Iran(21), and Brazil, educational interventions are  
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45 415 fundamental for nurses to guide their team and be the link of technical-scientific knowledge to  
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47 416 improve the quality of patient care (24). The possible reason might be that more educated  
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49 417 respondents have a higher opportunity of exposure to different courses directly or indirectly related  
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51 418 to the prevention of hypothermia.

52 419 Those nurses who received training related to hypothermia prevention were 3.7 and 2.6 times more  
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54 420 likely to have good knowledge and practice of hypothermia prevention as compared to  
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56 421 counterparts. This finding is supported by studies in Maryland, America(26), Brazil (36), Iran (21),

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3 422 Turkey(4). The possible reason might be because training plays an important role in improving the  
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5 423 quality of patient care. The need to promote the effectiveness of in-site and off-site training of  
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7 424 nurses is an invaluable criterion. Training is necessary to update theoretical and practical  
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9 425 knowledge in every aspect of nursing education(49).

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11 426 Another finding is nurses who were working in recovery and intensive care units were 2.9 and 2.4  
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13 427 times more likely to have good practice respectively as compared to the nurses who were working  
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15 428 in the emergency ward. This finding is inconsistent with the study conducted in Turkey, ICU  
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17 429 nurses had more knowledge than nurses who were working in other wards but their practice was  
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19 430 not changing (4). The possible reason why Recovery and ICU nurses had better practice might be  
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21 431 patients admitted in Recovery and ICU wards need close follow-up because of their physiological  
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23 432 change/disturbance due to surgery or anesthesia effect. So working in two wards, the nurses  
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25 433 perform more activities, which maintain thermoregulation. Another reason might be nurse to  
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27 434 patient ratio is better than other wards, the standard is in recovery one to two, ICU one to one,  
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29 435 emergency one to three, and for surgical and orthopedics wards is one to six in Ethiopia. The other  
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31 436 reason might have better availability of resources like a thermometer, warming materials. And also  
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33 437 might be most nurses who were working in those two wards took more training than other nurses.

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35 438 In this study, also nurses who are satisfied with their job were 2.2 times more likely to have a good  
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37 439 level of practice as compared to those who were not satisfied. Job satisfaction of the nurses is  
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39 440 highly important in building up employee interest and efficiency, as higher job satisfaction  
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41 441 determines better employee performance(50). Therefore, hospital administrators need to work on  
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43 442 improving working environments, so that nurses become safe and comfortable to result in a  
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45 443 positive feeling towards their job.

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47 444 The other significant variable is nurses who had knowledge of hypothermia were 2.6 times more  
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49 445 likely to have a good practice as compared to those who hadn't knowledge of hypothermia  
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51 446 prevention. This study has supported studies conducted at the University of Calabar, Nigeria (37)  
52  
53 447 and Textbook of Brunner & Suddarth (38), AORN, surgical team awareness, education, and  
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55 448 understanding of the effects of hypothermia are necessary components to change how clinicians  
56  
57 449 provide quality, cost-effective patient care (51).

### 450 **Strength and Limitations of the study**

451 A self-reported questionnaire measure of knowledge and practice of nurses on the prevention of  
452 perioperative hypothermia is prone to social desirability bias and recall bias. Furthermore, this  
453 study was not triangulated with a qualitative method. Despite these limitations, this study clearly  
454 showed the knowledge, practice, and associated factors of nurses toward perioperative  
455 hypothermia prevention among nurses working at comprehensive referral hospitals for the first  
456 time in Ethiopia.

457

### 458 **Conclusion**

459 This study revealed that nurses' knowledge and practice regarding the prevention of perioperative  
460 hypothermia was found to be inadequate as compared to the recommended guidelines. Having  
461 higher educational status, being male, and attending training showed a positive and significant  
462 association with good knowledge of perioperative hypothermia prevention. Whereas, factors  
463 contributing to practice were working ward, training, job satisfaction, and knowledge of nurses.  
464 Based on the findings of the study, we recommend to Amhara regional health bureau and hospital  
465 administrators including ward coordinators in collaboration with other stakeholders: Improve  
466 sponsored educational opportunities especially those nurses who have a diploma, promote and  
467 strengthen in-service training periodically and regularly, better to motivate those who have the  
468 knowledge and practiced well, should fulfill the availability of resources like warming materials,  
469 thermometers, and updated guidelines/protocols, better to improve working environments so that  
470 nurses become safe and comfortable to result in a positive feeling towards their job. Researchers  
471 also should do other research for a strong recommendation by adding observational data collection  
472 methods.

### 473 **List of Abbreviation**

474 AOR: Adjusted Odd Ratio; AORN: Association of perioperative Register Nurses; ASPAN:  
475 American Society of PeriAnesthesia Nurses; CI: Confidence Interval; DMRH: Debre Markos  
476 Referral Hospital; DTCRH: Debre Tabor Comprehensive Referral Hospital; EMS: Emergency

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3 477 Medical Service; EPI INFO: Statistical Package for Epidemiological Information Analysis;  
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5 478 FHRH: Felege Hiwot Referral Hospital; ICU: Intensive Care Unit; IPH: Inadvertent Perioperative  
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7 479 Hypothermia; OR: Odds Ratio; OR: Operation Room; HP: Perioperative Hypothermia; PI:  
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9 480 Principal Investigator; RR: Recovery Room; SPSS: Statistical Package of Social Science; T° c:  
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11 481 Temperature In Degree Centigrade; TGSRH: Tibebe Gion Specialized Referral Hospital; UK:  
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13 482 United Kingdom; UoGCSRH: University of Gondar Comprehensive Specialized Referral  
14  
15 483 Hospital; USA: United States of America  
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#### 20 484 **Declaration**

#### 21 485 **Ethical Approval and informed consent to participate**

22 486 The Institutional Ethical Review Board of the University of Gondar approved the study. Ethical  
23 487 clearance was obtained from the board on behalf of the School of Nursing (Ref.  
24 488 No. S/R/164/2/2021). Upon this clearance, additional written permission to conduct the study was  
25 489 obtained from the manager of all five referral hospitals when after explaining the purpose, the  
26 490 possible benefit of the study. Informed written consent was obtained from each respondent before  
27 491 fulfilling the questionnaire. It was explained for the respondents that participated in the study were  
28 492 voluntary and private information would be protected. The process no identify respondents by their  
29 493 name so; the process was done by keeping the privacy of the respondents.  
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#### 37 494 **Consent to publish**

38 495 Not applicable  
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#### 40 496 **Availability of data and materials:**

41 497 All the data were included in the study, and data will be available upon a responsible request from  
42 498 the corresponding author  
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#### 45 499 **Conflicts of Interest**

46 500 The authors declare that they have no conflicts of interest.  
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#### 49 501 **Funding**

50 502 No funder  
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#### 54 503 **Authors' contributions**



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3 504 Ashenafi Worku carried out the study starting from designing the study, analyzing, interpreting  
4 505 data, and reviewing the manuscript. Bezenaw Yimer Mekkonen, Netsanet Tsegaye, and  
5 506 Endalkachew Delle participated in proposal writing, data analysis, interpretation, and  
6 507 commenting drafts of the paper and manuscript. All authors involved in writing, review and  
7 508 approving the final draft of the manuscript. All authors read and approved the manuscript before  
8 509 submitted to the journal for publication.  
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21 514 School of Nursing, for making this thesis work by giving ethical clearance, and assigning advisors.  
22 515 We forward our appreciation to the five hospital administrators for allowing us to conduct this  
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24 517 volunteer participation, and data collectors and supervisors for their valuable support and  
25 518 cooperation during data collection.  
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24 661 **Figure 1:** Schematic presentation of sampling procedure of nurses' knowledge and practice, and  
25 662 associated factors on hypothermia prevention among surgical patients.  
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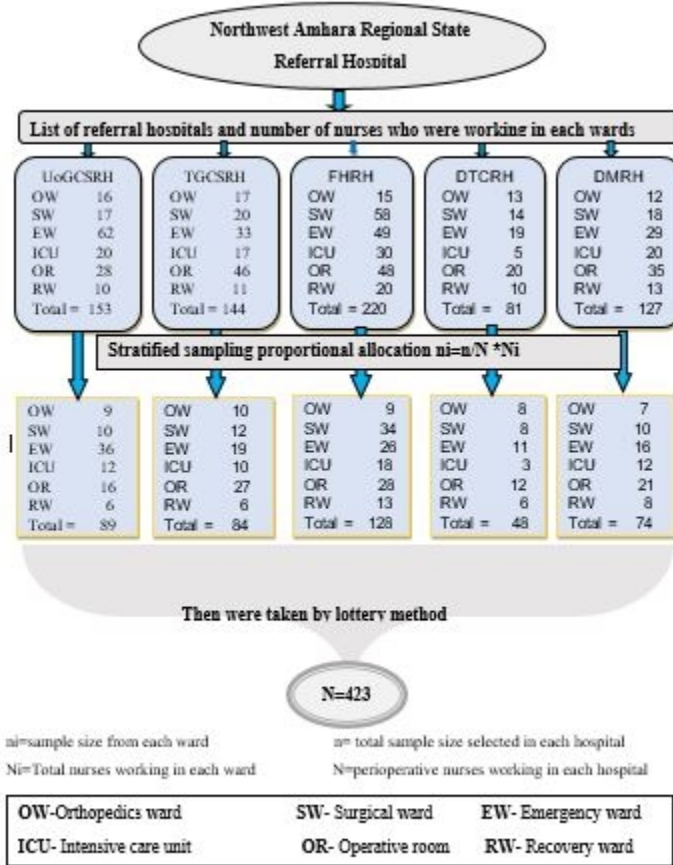


Figure 1: Schematic presentation of sampling procedure of nurses' knowledge and practice, and associated factors on hypothermia prevention among surgical patients.

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## STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2	Line (36); An institution-based cross-sectional study was conducted among 423 nurses who are working in perioperative units/wards of five referral hospitals from March 25-May 20/2021.
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2	Lines (28 – 54); Abstract
<b>Introduction</b>				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3 and 4	Lines (63 – 109); Introduction
Objectives	3	State-specific objectives, including any pre-specified hypotheses	4	Lines (107 – 109); This study aimed to assess nurses' knowledge, practice, and their determinant factors of perioperative hypothermia prevention in Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia.
<b>Methods</b>				
Study design	4	Present key elements of study design early in the paper	4	Lines (112 – 113); Institutional based cross-sectional study was conducted in perioperative units/wards of five referral hospitals from March 25-May 20/2021.



Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4, 5, and 6	Lines (112 – 162); Study design, period, and setting
Participants	6	(a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up  Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls  Cross-sectional study—Give the eligibility criteria and the sources and methods of selection of participants	6, 7, and 8	Lines (163 – 170); Source and study population  Lines (185 – 196); A total of 423 nurses were selected through a stratified random sampling technique, and data was collected from them.  Lines (197 – 204); Inclusion and exclusion criteria (eligibility criteria)
		(b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed  Case-control study—For matched studies, give matching criteria and the number of controls per case	N/A	This was a cross-sectional study
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8 and 9	Lines (205 – 227); Operational definition of variables
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	9	Lines (228 – 237); Data collection tools and procedures
Bias	9	Describe any efforts to address potential sources of bias	9	Lines (238–253); To maintain data quality training was given to data collectors and supervisors. the questionnaire was pretested

				among 5% of the sample size. Quality is also maintained by close monitoring of the procedure, and checking on the completeness of the data on-site by the responsibility of supervisors and the principal investigator.
Study size	10	Explain how the study size was arrived at	7	Lines (172–184); The sample size was determined by using a formula to estimate a single population proportion with the assumption of a 95% level of confidence, 50% proportion, and a 5% marginal error.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10	Lines (259–263); Binary logistic regression was used to determine the significant association between the independent and dependent variables. Those independent variables, which are less than 0.2 in bivariate analysis, were entered into multivariable logistic regressions. Association between the independent variable and dependent variable was considered significant if P-value was less than 0.05 from multivariate logistic regression analysis
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	10	Lines (254–266); Statistical Analysis
		(b) Describe any methods used to examine subgroups and interactions	N/A	There were no subgroups
		(c) Explain how missing data were addressed	N/A	There was no missing data
		(d) Cohort study—If applicable, explain how loss to follow-up was addressed  Case-control study—If applicable, explain how matching of cases and controls was addressed	N/A	Lines (186 – 196); A total of 423 nurses were selected through a stratified random sampling technique, and data was collected from them

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy		
		(e) Describe any sensitivity analyses	N/A	
<b>Results</b>				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	N/A	This was a cross-sectional study with only one stage.
		(b) Give reasons for non-participation at each stage	N/A	
		(c) Consider use of a flow diagram	N/A	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, institutional, other) and information on exposures and potential confounders	11, 12, and 13	Line (287-289); Table 1: Sociodemographic characteristics of the study participants on hypothermia prevention among perioperative patients in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021(N=413).  Line (298-299); Table 2: Institutional and other related factors of the respondents on perioperative hypothermia prevention in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021. (N=413).
		(b) Indicate number of participants with missing data for each variable of interest	N/A	There was no missing data
		(c) Cohort study—Summarise follow-up time (eg, average and total amount)	N/A	This was a cross-sectional study

Outcome data	15*	Cohort study—Report numbers of outcome events or summary measures over time	N/A	This was cross-sectional study
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A	This was a cross-sectional study
		Cross-sectional study—Report numbers of outcome events or summary measures	14 and 17	<p>Lines (292–293); In this study, 244 (59.1%) with 95% CI: (54.7, 63.7) of the participants had good knowledge while the rest were not knowledgeable.</p> <p>Lines (292–293); In this study, 208 (50.4%) with 95% CI: (45.5, 55) of the participants had good practice.</p>
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	14, 17, 19, and 21	<p>Lines (302-303); In this study, 244 (59.1%) with 95% CI: (54.7, 63.7) of the participants had good knowledge while the rest were not knowledgeable.</p> <p>Lines (321-322); In this study, 208 (50.4%) with 95% CI: (45.5, 55) of the participants had a good practice.</p> <p>Lines (344-345); Table 3- Bi-variable and multivariable analysis of factors associated with knowledge of nurses on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia.</p> <p>Lines (362-363); Table 4- Bi-variable and multivariable analysis of factors associated with the practice of nurses on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia.</p>

		(b) Report category boundaries when continuous variables were categorized	N/A	There was no continuous variable.
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A	There was no estimates of relative risk.
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A	There was no sub groups and sensitivity analysis.
<b>Discussion</b>				
Key results	18	Summarise key results with reference to study objectives	24-26	Lines (370–449); Discussion
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	26	Lines (450–453); A self-reported questionnaire measure of knowledge and practice of nurses on the prevention of perioperative hypothermia is prone to social desirability bias and recall bias. Furthermore, this study was not triangulated with a qualitative method.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	24-26	Lines (370-449); Discussion
Generalizability	21	Discuss the generalizability (external validity) of the study results	27	Lines (458-463); This study revealed that nurses' knowledge and practice regarding the prevention of perioperative hypothermia was found to be inadequate as compared to the recommended guidelines. Having higher educational status, being male, and attending training showed a positive and significant association with good knowledge of perioperative hypothermia prevention. Whereas, factors contributing to practice were working ward, training, job satisfaction, and knowledge of nurses.

<b>Other information</b>				
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\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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## Knowledge and Practice of nurses regarding Perioperative Hypothermia Prevention at Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia: a cross-sectional study

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3 **1 Knowledge and Practice of nurses regarding Perioperative Hypothermia Prevention at**  
4 **2 Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia: a cross-**  
5 **3 sectional study**

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46 21 **Word count:** 3,988 (Introduction to conclusion; excluding tables and figure).

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## 26 Abstract

27 **Objectives** Nurses are the primary responsible body to prevent the occurrence of hypothermia  
28 among surgical patients, as it has been reported that maintenance of normothermia decreases the  
29 length of hospitalization by approximately up to 40%, risk of surgical site infection by 64%, and  
30 also mortality rate by four folds. Therefore, the aim of this study was to assess nurses'  
31 knowledge, practices, and associated factors toward perioperative hypothermia prevention.

32 **Design** Cross-sectional study design.

33 **Setting** Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia.

34 **Participants** 413 nurses.

35 **Main outcome measures** Perioperative hypothermia prevention knowledge and practices among  
36 nurses

37 **Results** A total of 244 (59.1%) of the respondents had good knowledge and 208 (50.4%) had  
38 good practice in perioperative hypothermia prevention. Factors affecting nurses' knowledge on  
39 prevention of perioperative hypothermia were being male [AOR = 1.61, 95% CI (1.02-2.53)],  
40 having a bachelor, and master's degree [AOR = 2.50; 95% CI (1.25-5.00), and 4.39; (1.45-  
41 13.20)] respectively, and took training [AOR = 3.68; 95% CI (2.14-6.33)]. Whereas nurses who  
42 were working in recovery and intensive care units [AOR = 2.87; 95% CI (1.08-7.58), and 2.39;  
43 95% CI (1.09-5.22)] respectively, took training [AOR = 2.64; 95% CI (1.53-4.57)], had a Job  
44 satisfaction [AOR 2.15; 95% CI (1.34-3.43)], and knowledgeable nurses [AOR 2.64; 95% CI  
45 (1.63-4.27)] were factors affecting nurse's practice on perioperative hypothermia prevention.

46 **Conclusion** Nurses' knowledge and practice regarding prevention of perioperative hypothermia  
47 were found to be inadequate. So, it is better to strengthen training, educational opportunity, equip  
48 wards with standardized guidelines and materials, and motivate and create a safe working  
49 environment.

50 **Keywords:** Perioperative hypothermia, Ethiopia, Knowledge, Practice, Nurses.

## 51 Limitations and Strength of the study

- 52 ■ Due to the time constraint, observational data collection method was not done.
- 53 ■ Furthermore, this study was not triangulated with the qualitative method
- 54 ■ Due to the limited availability of literature, I have used unpublished sources.
- 55 ■ Despite these limitations, this study covers large setting area.

## 56 **Background**

57 Hypothermia is a common health problem in patients having surgery, that is characterized as a  
58 body temperature below 36 °c (96.8°F) and it is usually caused by too much heat loss from cold  
59 weather exposure, anesthetic effect, and administration of cold intravenous, or irrigation fluids  
60 (1-3). Hypothermia decelerates all physiologic roles including metabolic rate, mental awareness,  
61 nerve conduction, neuromuscular reaction times, and both the cardiovascular and respiratory  
62 systems, consequently disturbing patients' comfort and leading to longer hospitalizations, higher  
63 costs, and increased mortality (1, 4).

64 Different studies conducted in different areas revealed that the magnitude of perioperative  
65 hypothermia in Brazil 56.7%(5), in Australia 74% (6), in Turkey research hospital in Ankara,  
66 and Trakya University Hospital were 78.6% and 63.3% respectively (7, 8). Another studies  
67 conducted in Ethiopia, Tikur Anbessa Specialized Hospital the overall magnitude of  
68 preoperative, intraoperative, and postoperative hypothermia were 16.2%, 53.2%, and 31.3%,  
69 respectively (9) while, in University of Gondar Comprehensive Specialized Hospital  
70 (UoGCSRH) the incidence of Pre, Intra, and post-operative hypothermia were 23.4%, 49.7%,  
71 and 50.6% respectively (10). But available literature shows that nurses' knowledge and practice  
72 towards perioperative hypothermia prevention is low despite the high incidence, serious  
73 consequences, and availability of effective interventions to prevent and treat this frequent  
74 surgical complication (2, 11). Interventional studies conducted on perioperative hypothermia  
75 prevention in Brazil and Turkey, 55.9% and 61.77% of nurses had good knowledge respectively  
76 before they were taken the training (4, 12). Other cross-sectional study done in Ethiopia  
77 regarding perioperative hypothermia prevention on trauma patients, only 52.1% of nurses were  
78 had good knowledge (13). While studies conducted in south Africa and Gambia, 46% and 19%  
79 of nurses had good practice respectively on perioperative hypothermia prevention (11, 14).

80 According to the Association of Perioperative Register Nurses (AORN) Guideline, nurses need  
81 to have knowledge and skill on hypothermia prevention at the perioperative phase. This includes  
82 measuring the patient's body temperature, selecting methods for prevention of unintended  
83 hypothermia, and implementing the selected insulation and warming interventions (15).  
84 Warming intervention measures include warming patients before surgery, during surgery, and

1  
2  
3 85 after surgery by using passive insulation and active warming methods such as warmed cotton  
4  
5 86 blankets, surgical draping, thermal garments, forced-air warming devices, electric warming  
6  
7 87 blankets, and warmed fluids (16, 17).  
8

9 88 Preventing heat loss and maintaining normothermia are important nursing care in an early phase  
10  
11 89 of resuscitation as metabolic changes accompanied by injury cannot be corrected when patients  
12  
13 90 are in hypothermic status (18). Nurses need to be cognizant of the risks associated with each  
14  
15 91 perioperative phase of the patient in the prevention of hypothermia(19). Preserving a normal  
16  
17 92 body temperature during the surgical experience enhances the patient's chance of preventing  
18  
19 93 postoperative complications (20). Different evidence reported that the maintenance of  
20  
21 94 normothermia decreases the length of hospitalization by approximately up to 40%, risk of  
22  
23 95 surgical site infection by 64%, may prevent the costs of potential stay in the intensive care unit  
24  
25 96 by \$1,000 and a prolonged hospital stay by \$465 per day, and also decreasing mortality rate by  
26  
27 97 four folds (21-23).  
28

29 98 If nurses had not adequate knowledge and skill on the prevention of perioperative hypothermia,  
30  
31 99 its occurrence is inevitable. Even if nurses knowledge and practice are important in prevention of  
32  
33 100 perioperative hypothermia and its complication, available literature revealed that nurses had  
34  
35 101 significant knowledge and practice gaps (13). Different socio-demographic and institutional  
36  
37 102 factors which include age, marital status, educational level, work experience, presence of  
38  
39 103 guidelines and risk assessment protocol, taking training, reading updated evidence, and job  
40  
41 104 satisfaction affect nurses' knowledge and practice (2, 11, 24, 25).  
42

43 105 In Ethiopia, there are no studies is available regarding nurses' knowledge and practice on  
44  
45 106 perioperative hypothermia prevention. Therefore, the purpose of this study is to assess nurses'  
46  
47 107 knowledge, practice, and their determinant factors of perioperative hypothermia prevention in  
48  
49 108 Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia.  
50

## 51 109 **Methods**

### 52 110 **Study design and period**

53 111 Institutional based cross-sectional study was conducted in perioperative units/wards of five  
54  
55 112 referral hospitals from March 25-May 20/2021.  
56

## 113 **Study area**

114 The study was conducted in Northwest Amhara Regional State Referral Hospitals, Northwest  
115 Ethiopia. Northwest Amhara is found in the northwestern part of Ethiopia. There are five  
116 government referral hospitals in Northwest Amhara regional state such as University of Gondar  
117 Comprehensive Specialized Referral Hospital (UoGCSRH), Felege Hiwot Referral Hospital  
118 (FHRH), Tibebe Gion Specialized Referral Hospital (TGSRH), Debre Markos Referral Hospital  
119 (DMRH), and Debre Tabor Comprehensive Referral Hospital (DTCRH). All hospitals provide  
120 outpatient and inpatient services for more than 22,000,000 million people living in their  
121 catchment area. Surgical department is one of the actively serving departments giving emergency  
122 and elective surgery among the service given by the hospitals. All five hospitals have different  
123 surgical units in their surgical department such as surgical emergency ward, operation room,  
124 recovery ward, surgical ward, orthopedics ward, and surgical intensive care unit (ICU).  
125 According to information obtained from the administrative offices of these hospitals, there are  
126 1682 nurses, who provide services. Among those 725 nurses (153 in UoGCSRH, 220 in FHRH,  
127 144 in TGSRH, 127 in DMRH, and 81 in DTCRH) are working in our study unit (26-30). Nurses  
128 who are working in perioperative unit provide different hypothermia preventive activities like  
129 covering of patients by linens and blanket, measure patients' temperature, warming of  
130 intravenous fluids; adjust room temperature and so on. Because preventing perioperative  
131 hypothermia is a crucial role for nurses.

## 132 **Source population**

133 Source populations were all nurses who were working in emergency, operation room, recovery  
134 ward, surgical ward, orthopedics ward, and surgical ICU ward of Northwest Amhara Regional  
135 State Referral Hospitals, Northwest Ethiopia.

## 136 **Study population**

137 The study population included nurses who were working in emergency ward, operation room,  
138 recovery ward, surgical ward, orthopedics ward, and surgical ICU wards of UoGCSRH,  
139 DTCRH, DMRH, TGRH, and FHRH during the data collection period.

## 140 **Sample size and sampling procedure**

### 141 **Sample size**

1  
2  
3 142 The sample size of the study was calculated using the formula for the estimation of a single  
4  
5 143 population proportion and the assumptions were the proportion of knowledge and practice of  
6  
7 144 nurses regarding hypothermia prevention was 50% (since there was no study conducted in our  
8  
9 145 country), with 95% level of confidence and 5% margin of error. By using a z-value of 1.96 at  
10  
11 146 95% CI the minimum sample size for this study was:

12 147 As:  $n = Z_{\alpha/2}^2 * P (1-P) / d^2$

13  
14 148 n = sample size

15 149 p = proportion of knowledge & practice of nurses on hypothermia prevention =0.5

16  
17 150 d = maximum allowable error (margin of error) = 0.05

18  
19 151 Z = value of standard normal distribution at 95% confidence level ( $z=1.96$ ).

20  
21 152  $n = (1.96) (1.96) *(0.5) (1-0.5) / (0.05) (0.05) =384$  subjects;

22  
23 153  $\Rightarrow$  By adding 10% allowance for non-response rate the total sample size were

24  
25 154  $384+10%=423$

### 26 27 155 **Sampling procedure**

28  
29 156 The study was performed on nurses who were working at the emergency surgical (including  
30  
31 157 trauma unit), operation room, recovery ward, surgical ward, orthopedics ward, and surgical ICU  
32  
33 158 ward of Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia. A stratified  
34  
35 159 sampling technique was employed to recruit the required participant for the study. First, the  
36  
37 160 study participants are stratified from each hospital and working ward/unit and allocated the  
38  
39 161 required sample for each stratum proportionally. According to all hospitals of human resources,  
40  
41 162 administration reports the total number of nurses who were working in these units or wards was  
42  
43 163 725. Based on the number of nurses working in each hospital, 423 samples were proportionally  
44  
45 164 allocated from 725 (from 153 - 89 in UoGCSRH, from 144 - 84 in TGRH, from 220 -128 in  
46  
47 165 FHRH, from 81 - 48 in DTRH, and 127 - 74 in DMRH). Finally, those participants were taken  
48  
49 166 by lottery method of simple random sampling technique from each sampling frame  
50  
51 167 (Supplemental Figure)

### 52 53 168 **Inclusion and exclusion criteria**

54  
55 169 All nurses who were working in the surgical emergency, operation room, recovery ward, surgical  
56  
57 170 ICU, surgical & orthopedic ward of Northwest Amhara Regional State Referral Hospitals,  
58  
59 171 Northwest Ethiopia during the time of data collection were included in this study.

1  
2  
3 172 Matron and ward coordinator nurses were excluded because those nurses are primarily  
4 responsible is coordinating, monitoring, and evaluating the staff nurses rather they doing routine  
5 173 activities.  
6  
7 174

### 8 175 **Operational definitions**

9  
10 176 **Knowledge:** Is theoretical or practical understanding of hypothermia and its prevention method  
11 through education or experience. Based on this research the percentage scores were graded as  
12 177 'poor', and 'good to determine the knowledge level.  
13  
14 178

15  
16 179 **Good knowledge:** If the study participants answer the knowledge questions above or equal to the  
17 computed median were considered as having good knowledge.  
18 180

19  
20 181 **Poor knowledge:** If the study participants answer, the knowledge questions below the computed  
21 median were considered as having poor knowledge.  
22 182

23  
24 183 **Practice:** Activities acting by nurses to prevent hypothermia. Items in this category of the Likert  
25 scale were coded as 0 to 2 for: never, sometimes, and always.  
26 184

27  
28 185 **Good practice:** The study participants who answer above or equal to the computed median of  
29 practice questions were considered as having good practice.  
30 186

31  
32 187 **Poor practice:** The study participants who answer below the computed median of practice  
33 questions were considered as having poor practice.  
34 188

35  
36 189 **Job satisfaction:** When the total score for the job satisfaction questionnaire was greater than or  
37 equal to the computed median, we said they were satisfied, and less than the computed median,  
38 190 we said they were dissatisfied with the overall aspect of their work.  
39 191  
40  
41  
42

### 43 192 **Data collection instruments and procedure**

44  
45  
46 193 Data was collected by using a self-administered questionnaire which was adapted from  
47 guidelines of AORN and NICE perioperative hypothermia prevention, and other literature which  
48 194 involves 27 questions for knowledge and 14 questions for practice (11, 31-33), and 15 questions  
49 195 for Socio-demographic, institutional and other characteristics (2, 4, 11, 24, 25, 31, 34). The  
50 196 questioners were prepared in the English language based on the study objectives, focusing on the  
51 197 background information of hypothermia and its prevention. Five BSc nurse staff who was  
52  
53  
54  
55 198

1  
2  
3 199 working other than the study wards were recruited for data collection and two MSc holder nurses  
4  
5 200 were recruited as a supervisor. Overall, the data collection process was coordinate and supervises  
6  
7 201 by the principal investigator.

### 8 9 202 **Data quality control**

10  
11 203 In order to ensure the quality of the collected data, data collectors and supervisors underwent  
12  
13 204 one-day training on the purpose of the study and the data collection procedure. The questionnaire  
14  
15 205 was additionally pretested at Woldia Comprehensive Referral Hospital with 5% of the sample  
16  
17 206 size. Internal consistency was checked by computing Cronbach's  $\alpha$  for both dependent variable  
18  
19 207 and job satisfaction questionnaires. The tests were shows 0.81, 0.77, and 0.91 for knowledge,  
20  
21 208 practice, and job satisfaction respectively. Supervisors and primary investigator conducted  
22  
23 209 routine supervision to verify the consistency and completeness of the questionnaires that were  
24  
25 210 filled out. Incomplete questionnaires were put in offices arranged for this purpose so that  
26  
27 211 participants completed their questionnaires.

### 28 212 **Data processing and analysis**

29  
30 213 After the data was checked for its consistency and completeness, data were entered into Epi Info  
31  
32 214 version 7 and exported into SPSS version 25 for analysis. A frequency table was used to describe  
33  
34 215 the participant characteristics knowledge and practice scores. Multicollinearity was checked by  
35  
36 216 using the variance inflation factor and its values were between 1 and 10. Model adequacy was  
37  
38 217 checked by using Hosmer-Lemeshow goodness of fit test and the model was fitted well which  
39  
40 218 indicates .856 and .993 for knowledge and practice respectively. Binary logistic regression was  
41  
42 219 used to determine the significant association between the independent and dependent variables.  
43  
44 220 Those independent variables, which are less than 0.2 in bivariate analysis, were entered into  
45  
46 221 multivariable logistic regressions. Association between the independent variable and dependent  
47  
48 222 variable was considered significant if P-value was less than 0.05 from multivariate logistic  
49  
50 223 regression analysis.

### 51 224 **Patient and public involvement**

52 225 It was not appropriate or possible to involve patients or public in the design, conduct, report or  
53  
54 226 dissemination plans of our research because this study was done on Nurses.



## 227 Results

### 228 Socio-demographic characteristics of the respondents

229 A total of 423, with a response rate of 97.6% of study participants were involved in this study.  
 230 The median age (IQR) of the study participants was 29 (27, 32) years, ranging from 20-58 years  
 231 and almost half of the participants were under the age category between 26 to 30 years. Two  
 232 hundred thirteen (51.6%) of the participants were male, and 235(56.9%) were married. Out of  
 233 413 nurses, three-fourth of the respondents had a bachelor's degree (Table1).

234 Table 1: Socio-demographic characteristics of the study participants on perioperative  
 235 hypothermia prevention in Amhara Regional State Referral Hospitals, Northwest Ethiopia,  
 236 2021(N=413).

Variable	Response	Frequency (N=413)	Percentage (%)
Sex	Male	213	51.6
	Female	200	48.4
Age	≤ 25 years	53	12.8
	26-30	224	54.2
	31-35	86	20.8
	≥ 35	50	12.1
Marital status	Single	163	39.5
	Married	235	56.9
	Divorced	12	2.9
	Widowed	3	.7
Educational status	Diploma	59	14.3
	Degree	311	75.3
	Master	43	10.4

<b>Work experience</b>	≤ 5 years	157	38
	6-10	181	43.8
	11-15	57	13.8
	≥ 16	18	4.4
<b>Monthly salary(ETB)</b>	≤ 5000	42	10.2
	5001-7000	158	38.3
	7001-9000	172	41.6
	≥ 9001	41	9.9

237 *ETB- Ethiopian Birr*

### 238 **Institutional and job-related factors of the respondents**

239 From 413, 268(64.9%) of nurses did not take training about perioperative hypothermia  
 240 prevention. half of the respondents reports that they were reading or reviewing updated evidence,  
 241 and only 121(29.3%) of participants have notified the presence of guidelines or protocols in their  
 242 working area. Out of the study participants 268 (64.9%) and 342 (82.8%) were having a shortage  
 243 of thermometers and warming materials respectively. From 413 study participants near half of  
 244 217 (52.5%) participants were satisfied with their jobs (Supplemental Table).

### 245 **Knowledge of nurses on hypothermia prevention**

246 The overall median knowledge score of the study participants on perioperative hypothermia  
 247 prevention was 18 with an IQR of (16, 21). In this study, 244 (59.1%) with 95% CI: (54.7, 63.7)  
 248 of the participants had good knowledge. Among a total of knowledge assessment questions,  
 249 359(86.9%) and 288(69.7%) of participants have correctly answered the statement about the  
 250 definition of thermoregulation and perioperative hypothermia respectively. Three-fourth of the  
 251 participants gave the correct answer of anesthetic drugs increase heat loss while 250(60.5) of the  
 252 participants correctly answered the complications of hypothermia in surgical patients. Only  
 253 83(20.1%) of the participants were correctly respond in the theatre room, the patient's

254 temperature should be measured every 30 minutes while in the recovery room, every 15 minutes  
 255 (Table 2).

256 Table 2. Nurse's responses on knowledge of perioperative hypothermia prevention (N=413)

Statements about perioperative hypothermia prevention	True/ False	Correct answer		Wrong answer /I don't know	
		N	%	N	%
The internal environment of humans can be maintained by thermoregulation.	T*	359	86.9	54	13.1
PH at any time during the perioperative cycle is characterized as a core body temperature < 36 ° C.	T*	288	69.7	125	30.3
Anesthetic drugs decrease heat loss in surgical patients.	F**	311	75.3	102	24.7
Cold IV fluids and blood products increase heat loss.	T*	288	69.5	126	30.5
PH is not associated with complications such as changes in drug metabolism, healing complications, shivering, clotting defects, cardiac morbidity, and prolonged post-anesthetic recovery.	F**	250	60.5	163	39.5
To minimize post-operative complications, nurses should advise patients to bring along additional clothing to help them stay warm before surgery	T*	339	82.1	74	17.9
The pulmonary artery catheter, distal esophagus, urinary bladder, rectum, zero heat-flux are some of the sites for temperature measurements.	T*	174	42.1	239	57.9
Nurses should be well trained and knowledgeable about the use of both temperature recording and warming devices	T*	346	83.8	67	16.2
Forced-air warming devices, warm water circulating and conductive devices are not some of the devices for warming surgical patients	F**	241	58.4	172	41.6
The method for temperature monitoring should not be chosen based on the criteria for a procedure	F**	281	68	132	32
To ensure accurate information, the team takes the patient's temperature at 15- minute intervals using different measuring devices at different sites.	F**	138	33.4	275	66.6
Patients with temperature < 36.0°C undergoing anesthesia & those having a high risk of cardiovascular complications are at higher risk for IPH	T*	293	70.9	120	29.1
It is not necessary to measure patients' temperature in the hour before departing the ward since it will be measured at the theatre.	F**	279	67.6	134	32.4

1 2 3 4 5 6	Except in urgent circumstances, preoperative patients with temperatures of < 36.0°C should be warmed for 30' by using active warming method	T*	284	68.8	129	31.2
7 8 9	Special attention should be given to the comfort of surgical patients having difficulties expressing themselves	T*	335	81.1	78	18.9
10 11 12 13	The method for warming patients should be chosen based on planned procedure, patient position, IV access site, and warming equipment constraints.	T*	333	80.6	80	19.4
14 15 16	Critical incidence reporting is not necessary for patients coming into the theatre with a temperature of less than 36.0°C.	F**	259	62.7	154	37.3
17 18 19	Induction of anesthesia should not begin unless the patient's temperature is 36.0°C or above.	T*	203	49.2	210	50.8
20 21 22 23	The theatre's room temperature should be at least 21°C which can be adjusted to allow better working once active warming is initiated.	T*	273	66.1	140	33.9
24 25 26	All irrigation fluids used intraoperative should be warmed in a thermostatically controlled cabinet to a temperature of 38- 40°C.	T*	214	51.8	199	48.2
27 28 29	Fluid warming devices should be used to warm IV fluids (500mls or more) & blood products to 37°C	T*	260	63	153	37
30 31 32	Regardless of the temperatures of patients before leaving the ward, they should be warmed using active warming method once in the theatre	T*	256	62	157	38
33 34 35	The surgical patient should be well covered throughout surgery to conserve heat and only be exposed during surgical preparation.	T*	310	75.1	103	24.9
36 37 38	During the post-operative period, hypothermic patients should be warmed using AWM until they become warm before transferring them to the ward.	T*	348	84.3	65	15.7
39 40 41	Patients should be provided with at least 1 cotton sheet, 2 blankets, or a duvet during the postoperative phase	T*	319	77.2	94	22.8
42 43 44	Whiles in the OR, the patients' temperature should be measured every 15 minutes and every 30 minutes while in the RR.	F**	83	20.1	330	79.9
45 46 47 48	The temperature of post-operative patients should be recorded on arrival in the ward and be documented as part of a routine 4 hrs observations.	T*	337	81.6	76	18.4

257 T\*-True statement, F\*\*- False statement, N- Number of participants.

## 258 Practice of nurses on hypothermia prevention

259 The overall median practice score of the study participants on perioperative hypothermia  
260 prevention was 18 with an IQR of (14, 21). In this study, 208 (50.4%) with 95% CI: (45.5, 55) of

the participants had a good practice. Among practice assessment questions, 258(62.5%) of the respondents they measure temperature as soon as patient arrival and 224(54.2 %) of the respondents were always assessing the sign and symptoms of hypothermia. Nearly half of the respondents 214(51.8%) and 213(51.6%) were sometimes maintaining ambient room temperature according to guidelines and also applying warm intravenous, blood products, and irrigation fluids respectively. Among 413 participants, 185(44.8%) of the respondents were reported never using forced-air warming devices, warm water circulating devices, and conductive devices for warming surgical patients (Table 3).

Table 3. Nurse's responses on the practice of perioperative hypothermia prevention in Northwest Amhara Regional State Referral Hospitals, Northwest, Ethiopia (N=413)

Hypothermia prevention practices	Never		Some times		Always	
	N	%	N	%	N	%
Do you measure temperature as soon as patient arrival?	21	5.1	134	32.4	258	62.5
Do you measure temperature regularly according to guidelines?	50	12.1	202	48.9	161	39
Do you warm intravenous, blood products, and irrigation fluids using warming devices before administering to patients?	112	27.1	213	51.6	88	21.3
Do you cover the mattress plastic sheet with dry linen before patient admission?	59	14.3	200	48.4	154	37.3
Do you use forced-air warming devices, warm water circulating devices, and conductive devices for warming patients?	185	44.8	170	41.2	58	14
Do you communicate your assessment findings on factors that could lead to hypothermia to all members of the perioperative team?	57	13.8	160	38.7	196	47.5
Do you advise patients to inform you when they feel cold during their hospitalization?	53	12.8	195	47.2	165	40

Do you develop and implement care plans for perioperative hypothermia prevention?	73	17.7	217	52.5	123	29.8
Do you document the site for temperature measurement in the patients' file?	63	15.3	156	37.8	194	47
Do you maintain ambient room temperature according to the guideline?	110	26.6	214	51.8	89	21.5
Do you assess patients for their risk for perioperative hypothermia?	41	9.9	202	48.9	170	41.2
Do you assess for signs and symptoms of hypothermia?	30	7.3	159	38.5	224	54.2
Do you advise patients to stay warm prior to surgery?	48	11.6	185	44.8	180	43.6
Do you include thermoregulation interventions and patient-related care to thermoregulation in your hand-over report	41	9.9	194	47	178	43.1

### 271 **Factors associated with the level of knowledge on hypothermia prevention**

272 In the binary logistic regression, ten from fifteen variables were found to have a significant  
 273 association with participants' level of knowledge on hypothermia at a p-value of < 0.2. However,  
 274 after adjusting for the effects of potentially confounding variables using multivariate logistic  
 275 regression, only gender, educational status, and training were found to be significant predictors  
 276 of knowledge about how to prevent hypothermia.

277 In this study, being male had 1.61 times more knowledge [AOR = 1.61, 95% CI (1.02-2.53)].  
 278 Study participants who had an educational level of degree and masters were 2.5 and 4.39 times  
 279 more likely to have good knowledge [AOR = 2.50; 95% CI (1.25-5.00), 4.39; (1.45-13.20)]  
 280 respectively. In this study also nurses who took training on perioperative hypothermia prevention  
 281 had 3.68 times more knowledge [AOR = 3.68; 95% CI (2.14-6.33)] (Table 4).

282 Table 4- Bi-variable and multivariable analysis of factors associated with knowledge of nurses  
 283 on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest  
 284 Ethiopia.

Variable	Knowledge of nurses		COR (95%CI)	P-value	AOR (95% CI)	P-value
	Good	Poor				
Sex						
Female	105	95	1		1	
Male	139	74	1.69(1.14-2.52)	.009	1.61(1.02-2.53)	.038**
Educational status						
Diploma	19	40	1		1	
Degree	191	120	3.35(1.85-6.05)	.000	2.50(1.25-5.00)	.010**
Master	34	9	7.95(3.18-19.8)	.000	4.39(1.45-13.2)	.008**
Hospital						
FHRH	67	59	1		1	
UoGCSRH	48	35	1.20(.69-2.11)	.314	1.18(.631-2.21)	.601
DMCRH	51	22	2.04(1.11-3.76)	.056	1.74(.863-3.49)	.118
DTCRH	33	14	2.08(1.01-4.25)	.046	2.16(.933-4.94)	.068
TGSRH	45	39	1.01(.58-1.77)	.955	1.20(.627-2.29)	.581
Ward						
Emergency	52	51	1		1	
Recovery	31	8	3.8(1.59-9.05)	.003	2.24(.862-5.84)	.098
ICU	34	19	1.75(.88-3.46)	.106	1.48(.696-3.16)	.307
OR	67	35	1.87(1.07-3.29)	.028	1.51(.799-2.86)	.203
Orthopedics	26	20	1.27(.63-2.56)	.496	1.35(.641-3.02)	.402
Surgical	34	36	.92(.50-1.70)	.805	.850(.431-1.67)	.640
Monthly salary(ETB)						

≤ 5000	18	21	1		1	
5001-7000	90	74	1.41(.7-2.85)	.477	1.10 (.478-2.35)	.885
7001-9000	107	64	1.95(.96-3.93)	.075	.848(.492-2.49)	.802
≥ 9001	29	10	3.38(1.3-8.79)	.010	1.53(.507-4.67)	.447
<b>Having guideline</b>						
No	124	168	1		1	
Yes	75	46	1.37(.88-2.1)	.153	.848(.490-1.46)	.555
<b>Took Training</b>						
No	128	140	1		1	
Yes	116	29	4.37(2.72-7.01)	.000	3.68(2.14-6.33)	.000**
<b>Reading updated evidence</b>						
No	106	100	1		1	
Yes	138	69	1.88(1.26-2.80)	.002	1.32(.834-2.10)	.234
<b>Shortage of thermometer</b>						
Yes	148	120	1		1	
No	96	49	1.58(1.04-2.41)	.031	1.27(.776-2.08)	.325
<b>Job satisfaction</b>						
Unsatisfied	100	95	1		1	
Satisfied	144	74	1.84(1.24-2.74)	.002	1.38(.873-2.20)	.166

285 Variables which show significant association during multivariable logistic regression at \*\*p-  
 286 value <0.05, Hosmer and Lemeshow test P=.856, 1=Reference.

### 287 **Factors associated with the level of practice on hypothermia prevention**

288 In bivariate logistic regression analysis, eleven from sixteen variables were found to have  
 289 significant predictors at a p-value < 0.2. But after controlling for the effects of potentially  
 290 confounding variables using multivariate logistic regression only nurses working ward, took



291 training, job satisfaction, and knowledge of nurses were found to be significant predictors for the  
 292 practice of nurses on hypothermia prevention at ( $P < 0.05$ ).

293 Nurses who were working in recovery and intensive care units were 2.87 and 2.39 times more  
 294 likely to have good practice [AOR = 2.87; 95% CI (1.08-7.58), and 2.39; 95% CI (1.09-5.22)]  
 295 respectively. Nurses who took training in hypothermia prevention were 2.64 times more likely to  
 296 have good practices for hypothermia prevention [AOR = 2.64; 95% CI (1.53-4.57)]. In this study,  
 297 also nurses who are satisfied with their job were 2.15 times higher to have a good level of  
 298 practice [AOR 2.15; 95% CI (1.34-3.43)]. The other significant variable is nurses who had  
 299 knowledge of hypothermia were 2.64 times higher to have a good level of practice [AOR 2.64;  
 300 95% CI (1.63-4.27)] (Table 5)

301 Table 5- Bi-variable and multivariable analysis of factors associated with the practice of nurses  
 302 on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest  
 303 Ethiopia.

Variable	Practice of nurses		COR (95%CI)	P-value	AOR (95% CI)	P-value
	Good	Poor				
Educational status						
Diploma	16	43	1		1	
Degree	159	152	2.81(1.51-5.20)	.000	1.94(.902-4.20)	.089
Master	24	19	3.39(1.47-7.79)	.002	1.28(.411-4.00)	.669
Working ward						
Emergency	41	62	1		1	
Recovery	30	9	5.04(2.1-11.71)	.000	2.87(1.08-7.58)	.033**
ICU	34	19	2.70(1.36-5.37)	.004	2.39(1.09-5.22)	.029**
OR	59	43	2.07(1.18-3.62)	.010	1.63(.856-3.12)	.136
Orthopedics	20	26	1.16(.575-2.35)	.674	1.17(.527-2.62)	.693

Surgical	24	46	.78(.419-1.48)	.467	.657(.321-1.34)	.250
Work experience						
≤ 5 years	69	88	1		1	
6-10	95	86	1.4(.917-2.16)	.118	1.26(.713-2.23)	.424
11-15	32	25	1.63(.886-3.00)	.116	1.68(.735-3.86)	.217
≥ 16	12	6	2.55(.911-7.14)	.075	3.26(.85-12.44)	.083
Monthly salary(ETB)						
≤ 5000	17	25	1		1	
5001-7000	67	91	1.08(.542-2.16)	.822	1.01(.436-2.35)	.976
7001-9000	98	74	1.94(.987-3.86)	.057	1.26(.517-3.10)	.604
≥ 9001	26	15	2.54(1.05-6.17)	.038	1.05(.310-3.58)	.933
Having guideline/ protocol						
No	131	161	1		1	
Yes	77	44	2.15(1.39-3.32)	.001	1.42(.824-2.47)	.205
Took training						
No	104	164	1		1	
Yes	104	41	4.00(2.58-6.19)	.000	2.64(1.53-4.57)	.001**
Reading updated evidence						
No	84	122	1		1	
Yes	124	83	2.17(1.46-3.21)	.000	1.37(.853-2.21)	.192
Constraint of thermometer						
Yes	123	145	1.67(1.11-2.51)	.014	1.10(.661-1.83)	.711
No	85	60	1		1	
Shortage of warming material						

Yes	166	176	1.53(.914-2.57)	.105	1.77(.923-3.39)	.086
No	42	29	1		1	
Job satisfaction						
Unsatisfied	71	124	1		1	
Satisfied	137	81	2.95(1.97-4.41)	.000	2.15(1.34-3.43)	.001**
Knowledge						
Good	157	87	4.17(2.74-6.35)	.000	2.64(1.63-4.27)	.000**
Poor	51	118	1		1	

304 Variables which show significant association during multivariable logistic regression at\*\* p-  
 305 value <0.05, Hosmer and Lemeshow test P=.993, 1=Reference.

### 306 Discussion

307 The result of this study showed that the overall knowledge of nurses on perioperative  
 308 hypothermia prevention was 59.1% with 95% CI (54.7, 63.7). This finding is higher than  
 309 previous studies conducted Addis Ababa, Ethiopia(52.1%) (13). The possible reason might be  
 310 due to socio-demographic differences, in the previous study most participants were having a  
 311 degree and diploma level of educational status and the study area was a single setting of trauma  
 312 center while in the current study greater than 10% of the participant had masters and study  
 313 setting were multicenter. The other reason might be due to the difference in the time of the study  
 314 because of the advancement of technology including updated evidence; educational programs  
 315 were increased when the time is more and more recent. So, the participant might have to get  
 316 more information regarding the topics. But this finding is much lower than those of studies  
 317 conducted in Gambia (82%) (11), Turkey(77.5%) (4), Brazil (81.5%) (12), University of Iowa  
 318 Hospitals and Clinics, America (71%) (35), Maryland, America (100%) (36), Ireland (37), and  
 319 also as compare to NICE, AORN, and ASPAN guidelines of perioperative hypothermia  
 320 prevention (3, 15, 38). The possible justification for this difference might be due to the level of  
 321 staff training, adopted recommended guidelines, socioeconomic status, and sample size.  
 322 According to training on hypothermia prevention in this study, only a few nurses (35.1%) have  
 323 been trained while in the comparison group except in Gambia, almost all participants were taking

1  
2  
3 324 training on perioperative hypothermia prevention. In terms of using guideline/protocol, the  
4  
5 325 studies conducted in America participants always used recommended guidelines and protocols  
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7 326 while in this study only 29.3% of nurses were report having guidelines/protocols. According to  
8  
9 327 difference in socioeconomic status of the participants as well as study setting, we Ethiopians are  
10  
11 328 under a low-income country compared to America, Brazil, and Ireland. This is indirectly affects  
12  
13 329 the quality of healthcare education as well as healthcare setting. In terms of sample size in the  
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15 330 present study has a larger sample size (n=413) as compare to all listed above (in Gambia (n=53),  
16  
17 331 Turkey (n=200), Brazil (n=21), University of Iowa Hospitals and Clinics, America n=30,  
18  
19 332 Maryland, America n=19, Ireland n=198).

20 333 In this study, the overall practice of nurses on perioperative hypothermia prevention was 50.4%  
21  
22 334 with 95%, CI (45.5-55). This is consistent with the studies done in Addis Ababa, Ethiopia  
23  
24 335 (52.5%)(13), and Durban, South Africa (46%) (14). But this study is higher than the study done  
25  
26 336 in Gambia (19%) (11). The possible reason might be the difference in socio-demographic  
27  
28 337 characteristics like most of the participants in the Gambia were have less than five years'  
29  
30 338 experience, and hadn't masters holder participants. On the other hand, the result of this study is  
31  
32 339 much lower when from NICE, AORN, and ASPAN recommendations guidelines (3,15, 38). This  
33  
34 340 discrepancy could be due to the insufficient availability of warming material, measurement  
35  
36 341 material, and guidelines or protocol or it might be also an inadequate opportunity for frequent  
37  
38 342 training for nurses.

39 343 Regarding the determinants of the level of knowledge on hypothermia prevention, this study has  
40  
41 344 found out that male nurses were found to have more knowledge with hypothermia prevention  
42  
43 345 by 1.6 times as compared to females. The reason might be females have an extra workload, most  
44  
45 346 home activities such as bearing and taking care of children, cooking, washing etc. are mostly  
46  
47 347 done by females (39). So due to being overloaded by other additional home activities they might  
48  
49 348 haven't enough time to scale up their knowledge.

50 349 Nurses who had degrees and masters were more likely to have good knowledge with  
51  
52 350 hypothermia prevention by 2.5 and 4.4 times respectively as compared to those who had a  
53  
54 351 diploma. This finding is supported by studies conducted in Iran(24), and Brazil, educational  
55  
56 352 interventions are fundamental for nurses to guide their team and be the link of technical-

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3 353 scientific knowledge to improve the quality of patient care (12). The possible reason might be  
4  
5 354 that more educated respondents have a higher opportunity of exposure to different courses  
6  
7 355 directly or indirectly related to the prevention of hypothermia.

8  
9 356 Those nurses who received training related to hypothermia prevention were 3.7 and 2.6 times  
10  
11 357 more likely to have good knowledge and practice of hypothermia prevention as compared to  
12  
13 358 counterparts. This finding is supported by studies in Maryland, America(36), Brazil (40), Iran  
14  
15 359 (24), Turkey(4). The possible reason might be because training plays an important role in  
16  
17 360 improving the quality of patient care. The need to promote the effectiveness of in-site and off-  
18  
19 361 site training of nurses is an invaluable criterion. Training is necessary to update theoretical and  
20  
21 362 practical knowledge in every aspect of nursing education(39).

22 363 Another finding is nurses who were working in recovery and intensive care units were 2.9 and  
23  
24 364 2.4 times more likely to have good practice respectively as compared to the nurses who were  
25  
26 365 working in the emergency ward. This finding is inconsistent with the study conducted in Turkey,  
27  
28 366 ICU nurses had more knowledge than nurses who were working in other wards but their practice  
29  
30 367 was not changing (4). The possible reason why Recovery and ICU nurses had better practice  
31  
32 368 might be patients admitted in Recovery and ICU wards need close follow-up because of their  
33  
34 369 physiological change/disturbance due to surgery or anesthesia effect. So working in two wards,  
35  
36 370 the nurses perform more activities, which maintain thermoregulation. Another reason might be  
37  
38 371 nurse to patient ratio is better than other wards, the standard is in recovery one to two, ICU one  
39  
40 372 to one, emergency one to three, and for surgical and orthopedics wards is one to six in Ethiopia.  
41  
42 373 The other reason might have better availability of resources like a thermometer, warming  
43  
44 374 materials. And also might be most nurses who were working in those two wards took more  
45  
46 375 training than other nurses.

47  
48 376 In this study, also nurses who are satisfied with their job were 2.2 times more likely to have a  
49  
50 377 good level of practice as compared to those who were not satisfied. Job satisfaction of the nurses  
51  
52 378 is highly important in building up employee interest and efficiency, as higher job satisfaction  
53  
54 379 determines better employee performance(41). Therefore, hospital administrators need to work on  
55  
56 380 improving working environments, so that nurses become safe and comfortable to result in a  
57  
58 381 positive feeling towards their job.

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3 382 The other significant variable is nurses who had knowledge of hypothermia were 2.6 times more  
4  
5 383 likely to have a good practice as compared to those who hadn't knowledge of hypothermia  
6  
7 384 prevention. This study has supported studies conducted at the University of Calabar, Nigeria (42)  
8  
9 385 and Textbook of Brunner & Suddarth (43), AORN, surgical team awareness, education, and  
10  
11 386 understanding of the effects of hypothermia are necessary components to change how clinicians  
12  
13 387 provide quality, cost-effective patient care (44).

### 14 388 **Strength and Limitations of the study**

15  
16 389 A self-reported questionnaire measure of knowledge and practice of nurses on the prevention of  
17  
18 390 perioperative hypothermia is prone to social desirability bias and recall bias. Furthermore, this  
19  
20 391 study was not triangulated with a qualitative method. Despite these limitations, this study covers  
21  
22 392 large setting (multicenter) area.

### 23 24 393 **Conclusion**

25  
26 394 This study revealed that nurses' knowledge and practice regarding the prevention of perioperative  
27  
28 395 hypothermia was found to be inadequate as compared to the recommended guidelines. Having  
29  
30 396 higher educational status, being male and attending training showed a positive and significant  
31  
32 397 association with good knowledge of perioperative hypothermia prevention. Whereas, factors  
33  
34 398 contributing to practice were working ward, training, job satisfaction, and knowledge of nurses.  
35  
36 399 Based on the findings of the study, we recommend to Amhara regional health bureau and  
37  
38 400 hospital administrators including ward coordinators in collaboration with other stakeholders:  
39  
40 401 Improve sponsored educational opportunities especially those nurses who have a diploma,  
41  
42 402 promote and strengthen in-service training periodically and regularly, better to motivate those  
43  
44 403 who have the knowledge and practiced well, should fulfill the availability of resources like  
45  
46 404 warming materials, thermometers, and updated guidelines/protocols, better to improve working  
47  
48 405 environments so that nurses become safe and comfortable to result in a positive feeling towards  
49  
50 406 their job. Researchers also should do other research for a strong recommendation by adding  
51  
52 407 observational data collection methods.

### 53 54 55 56 57 58 59 60 408 **List of Abbreviation**

1  
2  
3 409 AOR: Adjusted Odd Ratio; AORN: Association of perioperative Register Nurses; ASPAN:  
4  
5 410 American Society of PeriAnesthesia Nurses; CI: Confidence Interval; DMRH: Debre Markos  
6  
7 411 Referral Hospital; DTCRH: Debre Tabor Comprehensive Referral Hospital; EMS: Emergency  
8  
9 412 Medical Service; EPI INFO: Statistical Package for Epidemiological Information Analysis;  
10  
11 413 FHRH: Felege Hiwot Referral Hospital; ICU: Intensive Care Unit; IPH: Inadvertent  
12  
13 414 Perioperative Hypothermia; OR: Odds Ratio; OR: Operation Room; HP: Perioperative  
14  
15 415 Hypothermia; PI: Principal Investigator; RR: Recovery Room; SPSS: Statistical Package of  
16  
17 416 Social Science; T° c: Temperature In Degree Centigrade; TGSRH: Tibebe Gion Specialized  
18  
19 417 Referral Hospital; UK: United Kingdom; UoGCSRH: University of Gondar Comprehensive  
20  
21 418 Specialized Referral Hospital; USA: United States of America  
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#### 26 419 **Declaration**

#### 28 420 **Ethical Approval and informed consent to participate**

29  
30 421 The Institutional Ethical Review Board of the University of Gondar approved the study. Ethical  
31  
32 422 clearance was obtained from the board on behalf of the School of Nursing (Ref.  
33  
34 423 No. S/R/164/2/2021). Upon this clearance, additional written permission to conduct the study  
35  
36 424 was obtained from the manager of all five referral hospitals when after explaining the purpose,  
37  
38 425 the possible benefit of the study. Informed written consent was obtained from each respondent  
39  
40 426 before fulfilling the questionnaire. It was explained for the respondents that participated in the  
41  
42 427 study were voluntary and private information would be protected. The processes no identify  
43  
44 428 respondents by their name so; the process was done by keeping the privacy of the respondents.

#### 44 429 **Consent to publish**

45 430 Not applicable

#### 47 431 **Availability of data and materials:**

48  
49 432 All data relevant to the study are included in the article or uploaded as supplementary  
50  
51 433 information

#### 52 434 **Conflicts of Interest**

53  
54 435 The authors declare that they have no conflicts of interest.  
55  
56

1  
2  
3 436 **Funding**  
4

5  
6 437 No funder  
7

8 438 **Authors' contributions**  
9

10  
11 439 Ashenafi Worku carried out the study starting from designing the study, analyzing, interpreting  
12 440 data, and reviewing the manuscript. Bezenaw Yimer Mekkonen, Netsanet Tsegaye, and  
13 441 Endalkachew Dellie participated in proposal writing, data analysis, interpretation, and  
14 442 commenting drafts of the paper and manuscript. All authors involved in writing, review and  
15 443 approving the final draft of the manuscript. All authors read and approved the manuscript before  
16 444 submitted to the journal for publication.  
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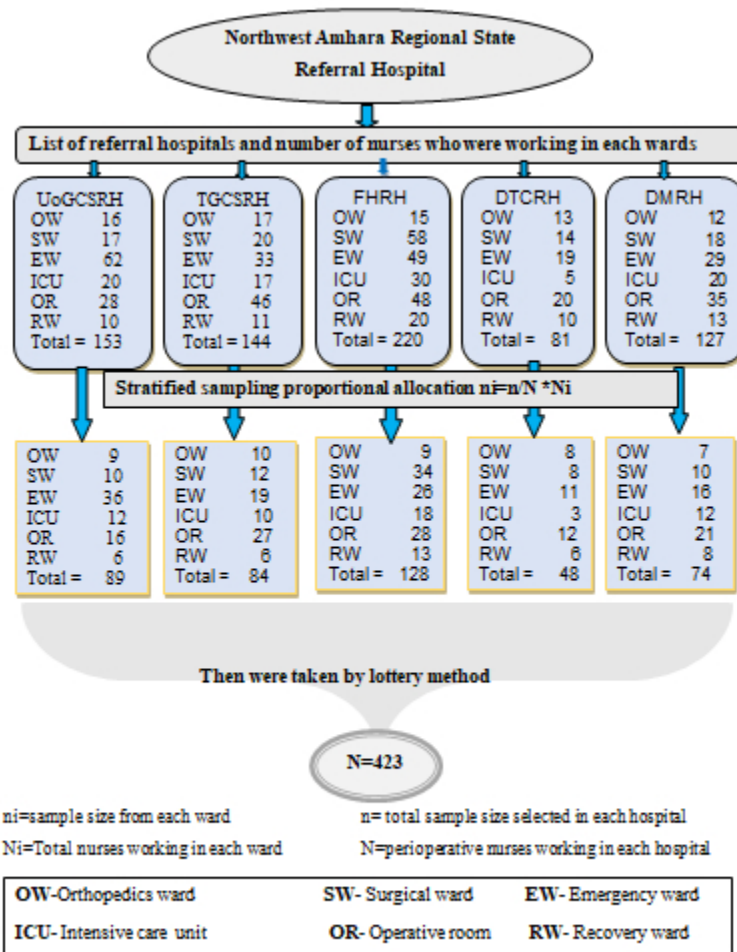
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8 581 hypothermia prevention in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021  
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14 584 **Supplemental Figure:** Schematic presentation of sampling procedure of nurses' knowledge and  
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16 585 practice, and associated factors on hypothermia prevention among surgical patients.  
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Supplemental Figure: Schematic presentation of sampling procedure of nurses' knowledge and practice, and associated factors on hypothermia prevention among surgical patients.

315x352mm (38 x 38 DPI)

Supplemental Table: Institutional and other related factors of the respondents on perioperative hypothermia prevention in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021 (N=413).

Variable	Response	Frequency (N=413)	Percentage (%)
Working place (hospital)	TGSRH	84	20.3
	UoGCSRH	83	20.1
	DMCRH	73	17.7
	DTCRH	47	11.4
	FHRH	126	30.5
Ward:	Emergency	103	24.9
	Recovery	39	9.4
	OR	102	24.7
	ICU	53	12.8
	Orthopedics ward	46	11.1
	Surgical ward	70	16.9
Daily working hours	≤ 8 hrs.	354	85.7
	≥9 hrs.	59	14.3
Training on hypothermia prevention	Yes	145	35.1
	No	268	64.9
Presence of protocol/guideline	Yes	121	29.3
	No	292	70.7
Reading updated evidence on hypothermia prevention	Yes	206	49.9
	No	207	50.1

Variable	Response	Frequency (N=413)	Percentage (%)
Availability of thermometer	Yes	145	35.1
	No	268	64.9
Constraints of warming material	Yes	342	82.8
	No	71	17.2
Shortage of blanket	Yes	166	40.2
	No	247	59.8
Shortage of linens	Yes	89	21.5
	No	324	78.5
Shortage of fluid warmer	Yes	132	32.0
	No	281	68.0
Shortage of air warmer/heater	Yes	212	51.3
	No	201	48.7
Shortage of warmer blanket	Yes	217	52.5
	No	196	47.5
Job satisfaction	Satisfied	217	52.5
	Dissatisfied	196	47.5



**STROBE Statement—checklist of items that should be included in reports of observational studies**

	<b>Item No.</b>	<b>Recommendation</b>	<b>Page No.</b>	<b>Relevant text from manuscript</b>
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1	Line (1-3); An institution-based cross-sectional study was conducted for the title of Knowledge and Practice of nurses regarding Perioperative Hypothermia Prevention at Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia:
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2	Lines (26 – 50); Abstract
<b>Introduction</b>				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3 and 4	Lines (56 – 108); Introduction
Objectives	3	State-specific objectives, including any pre-specified hypotheses	4	Lines (106 – 108); This study aimed to assess nurses' knowledge, practice, and their determinant factors of perioperative hypothermia prevention in Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia.
<b>Methods</b>				
Study design	4	Present key elements of study design early in the paper	4	Lines (110 – 112); Institutional based cross-sectional study was conducted in perioperative units/wards of five referral hospitals from March 25-May 20/2021.
Setting	5	Describe the setting, locations, and relevant dates,	5	Lines (113 – 131); Study setting

		including periods of recruitment, exposure, follow-up, and data collection		
Participants	6	<p>(a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up</p> <p>Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls</p> <p>Cross-sectional study—Give the eligibility criteria and the sources and methods of selection of participants</p>	5,6, and 7	<p>Lines (132 – 139); Source and study population</p> <p>Lines (155 – 167); A total of 423 nurses were selected through a stratified random sampling technique, and data was collected from 413 nurses.</p> <p>Lines (168– 174); Inclusion and exclusion criteria (eligibility criteria)</p>
		<p>(b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed</p> <p>Case-control study—For matched studies, give matching criteria and the number of controls per case</p>	N/A	This was a cross-sectional study
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7	Lines (175 – 191); Operational definition of variables
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7 and 8	Lines (192 – 201); Data collection tools and procedures
Bias	9	Describe any efforts to address potential sources of bias	8	Lines (202–211); To maintain data quality training was given to data collectors and supervisors. the questionnaire was pretested among 5% of the sample size. Quality was also maintained by

				close monitoring of the procedure, and checking on the completeness of the data on-site by the responsibility of supervisors and the principal investigator.
Study size	10	Explain how the study size was arrived at	5 and 6	Lines (140–154); The sample size was determined by using a formula to estimate a single population proportion with the assumption of a 95% level of confidence, 50% proportion, and a 5% marginal error.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9	Lines (218–223); Binary logistic regression was used to determine the significant association between the independent and dependent variables. Those independent variables, which are less than 0.2 in bivariate analysis, were entered into multivariable logistic regressions. Association between the independent variable and dependent variable was considered significant if P-value was less than 0.05 from multivariate logistic regression analysis
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8	Lines (213–223); Statistical Analysis
		(b) Describe any methods used to examine subgroups and interactions	N/A	There were no subgroups
		(c) Explain how missing data were addressed	N/A	There was no missing data
		(d) Cohort study—If applicable, explain how loss to follow-up was addressed  Case-control study—If applicable, explain how matching of cases and controls was addressed  Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	6	Lines (158 – 167); A total of 423 nurses were selected through a stratified random sampling technique, and data was collected from them

		(e) Describe any sensitivity analyses	N/A	
<b>Results</b>				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	N/A	This was a cross-sectional study with only one stage.
		(b) Give reasons for non-participation at each stage	N/A	
		(c) Consider use of a flow diagram	N/A	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, institutional, other) and information on exposures and potential confounders	9 and 10	Line (234-236); Table 1: Socio-demographic characteristics of the study participants on hypothermia prevention among perioperative patients in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021(N=413).  Line (238-244); <b>Institutional and job-related factors of the respondents</b> of the study participants
		(b) Indicate number of participants with missing data for each variable of interest	N/A	There was no missing data
		(c) Cohort study—Summarise follow-up time (eg, average and total amount)	N/A	This was a cross-sectional study
Outcome data	15*	Cohort study—Report numbers of outcome events or summary measures over time	N/A	This was cross-sectional study
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A	This was a cross-sectional study

		Cross-sectional study—Report numbers of outcome events or summary measures	10, 12, and 13	<p>Lines (246–248); In this study, 244 (59.1%) with 95% CI: (54.7, 63.7) of the participants had good knowledge</p> <p>Lines (260–262); In this study, 208 (50.4%) with 95% CI: (45.5, 55) of the participants had good practice.</p>
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10, 12, 13, and 20	<p>Lines (246-248); In this study, 244 (59.1%) with 95% CI: (54.7, 63.7) of the participants had good knowledge</p> <p>Lines (260-262); In this study, 208 (50.4%) with 95% CI: (45.5, 55) of the participants had a good practice.</p> <p>Lines (282-284); Table 4- Bi-variable and multivariable analysis of factors associated with knowledge of nurses on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia.</p> <p>Lines (301-303); Table 5- Bi-variable and multivariable analysis of factors associated with the practice of nurses on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia.</p>
		(b) Report category boundaries when continuous variables were categorized	N/A	There was no continuous variable.
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A	There was no estimate of relative risk.
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A	There was no sub groups and sensitivity analysis.
<b>Discussion</b>				

Key results	18	Summarise key results with reference to study objectives	19-22	Lines (306–387); Discussion
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	22	Lines (389–392); A self-reported questionnaire measure of knowledge and practice of nurses on the prevention of perioperative hypothermia is prone to social desirability bias and recall bias. Furthermore, this study was not triangulated with a qualitative method.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	19-22	Lines (306-392); Discussion and limitation and strength
Generalizability	21	Discuss the generalizability (external validity) of the study results	22	Lines (393-407); This study revealed that nurses' knowledge and practice regarding the prevention of perioperative hypothermia was found to be inadequate as compared to the recommended guidelines. Having higher educational status, being male, and attending training showed a positive and significant association with good knowledge of perioperative hypothermia prevention. Whereas, factors contributing to practice were working ward, training, job satisfaction, and knowledge of nurses.
<b>Other information</b>				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	24	Lines (437)-This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

# BMJ Open

## Knowledge and Practice of Nurses regarding Perioperative Hypothermia Prevention at Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia: A cross-sectional study

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<b>Primary Subject Heading</b>:	Nursing
Secondary Subject Heading:	Surgery, Nutrition and metabolism
Keywords:	NUTRITION & DIETETICS, PAIN MANAGEMENT, SURGERY

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3 1 **Knowledge and Practice of Nurses regarding Perioperative Hypothermia Prevention at**  
4 **Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia: A cross-**  
5 **sectional study**  
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9 4 Ashenafi Worku Woretaw<sup>1</sup>, Bezenaw Yimer Mekkonen <sup>2</sup>, Netsanet Tsegaye<sup>2</sup>, and Endalkachew  
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## 27 Abstract

28 **Objectives** Nurses are primarily responsible body to preventing the occurrence of hypothermia  
29 among surgical patients, as it has been reported that maintenance of normal body temperature  
30 decreases the length of hospitalization by approximately up to 40%, the risk of surgical site  
31 infection by 64%, and mortality rate by four folds. Therefore this study aimed to assess nurses'  
32 knowledge, practices, and associated factors toward perioperative hypothermia prevention.

33 **Design** Cross-sectional study design.

34 **Setting** Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia

35 **Participants** A total of 413 nurses were working in a perioperative unit of five referral hospitals.

36 **Main outcome measures** Perioperative hypothermia prevention knowledge and practices among  
37 nurses

38 **Results** A total of 244 (59.1%) of the respondents had good knowledge and 208 (50.4%) had  
39 good practice in perioperative hypothermia prevention. Factors affecting nurses' knowledge on  
40 prevention of perioperative hypothermia were being male [AOR = 1.61, 95% CI (1.02-2.53)],  
41 having a bachelor, and master's degree [AOR = 2.50; 95% CI (1.25-5.00), and 4.39; (1.45-  
42 13.20)] respectively, and took training [AOR = 3.68; 95% CI (2.14-6.33)]. Whereas nurses who  
43 were working in recovery and intensive care units [AOR = 2.87; 95% CI (1.08-7.58), and 2.39;  
44 95% CI (1.09-5.22)] respectively, took training [AOR = 2.64; 95% CI (1.53-4.57)], had a Job  
45 satisfaction [AOR 2.15; 95% CI (1.34-3.43)], and knowledgeable nurses [AOR 2.64; 95% CI  
46 (1.63-4.27)] were factors affecting nurse's practice on perioperative hypothermia prevention.

47 **Conclusion** Nurses' knowledge and practice regarding the prevention of perioperative  
48 hypothermia were found to be inadequate. So, it is better to strengthen training, educational  
49 opportunities, equip wards with standardized guidelines and materials, and motivate and create a  
50 safe working environment.

51 **Keywords:** Perioperative hypothermia, Ethiopia, Knowledge, Practice, Nurses.

## 52 Limitations and Strengths of the Study

- 53 ■ Due to the time constraint, the observational data collection method was not done.
- 54 ■ Furthermore, this study was not triangulated with the qualitative method
- 55 ■ Due to the limited availability of literature, I have used unpublished sources.
- 56 ■ Despite these limitations, this study covers a large setting area.

## 57 **Background**

58 Hypothermia is a common health problem in patients having surgery, that is characterized as a  
59 body temperature below 36°C (96.8°F) and it is usually caused by too much heat loss from cold  
60 weather exposure, anesthetic effect, and administration of cold intravenous, or irrigation fluids  
61 (1-3). Hypothermia decelerates all physiologic roles including metabolic rate, mental awareness,  
62 nerve conduction, neuromuscular reaction times, and both the cardiovascular and respiratory  
63 systems, consequently disturbing patients' comfort and leading to longer hospitalizations, higher  
64 costs, and increasing mortality (1, 4).

65 Different studies conducted in different areas revealed that the magnitude of perioperative  
66 hypothermia in Brazil was 56.7%(5), in Australia 74% (6), and in Turkey research hospital  
67 hospitals of Ankara, and Trakya University Hospital were 78.6% and 63.3% respectively (7, 8).  
68 In other studies conducted in Thailand, the incidence of preoperative, intraoperative, and  
69 postoperative hypothermia was 0.4%, 73.5%, and 11.9% respectively (9). While the study  
70 conducted in Deutschland to evaluate the hypothermia rates achieved with pre-warming and  
71 without pre-warming methods the result revealed patients subjected to pre-warming showed an  
72 intraoperative hypothermia rate of 15.8% and a postoperative hypothermia rate of 5.1% while  
73 patients without pre-warming showed an intraoperative hypothermia rate of 30.4% and  
74 a postoperative hypothermia rate of 12.4%. This means a 52% reduction in the intraoperative  
75 hypothermia rate and a 41% reduction in the postoperative hypothermia rate for patients who  
76 received pre-warming (10). Furthermore, studies conducted in Ethiopia, Tikur Anbessa  
77 Specialized Hospital the overall magnitude of preoperative, intraoperative, and postoperative  
78 hypothermia were 16.2%, 53.2%, and 31.3%, respectively (11) while, in the University of  
79 Gondar Comprehensive Specialized Referral Hospital (UoGCSRH) the incidence of pre, intra,  
80 and post-operative hypothermia were 23.4%, 49.7%, and 50.6% respectively (12). However  
81 available literature shows that nurses' knowledge and practice towards perioperative  
82 hypothermia prevention is low despite the high incidence, serious consequences, and availability  
83 of effective interventions to prevent and treat this frequent surgical complication (2, 13). In  
84 interventional studies conducted on perioperative hypothermia prevention in Brazil and Turkey,  
85 55.9% and 61.77% of nurses had good knowledge respectively before they were taken the  
86 training (4, 14). Another cross-sectional study was done in Ethiopia regarding perioperative

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3 87 hypothermia prevention in trauma patients, only 52.1% of nurses had good knowledge (15). In  
4 88 studies conducted in South Africa and Gambia, 46% and 19% of nurses had good practice  
5 89 respectively on perioperative hypothermia prevention (13, 16).  
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9 90 According to the Association of Perioperative Register Nurses (AORN) Guideline, nurses need  
10 91 to have knowledge and skills on hypothermia prevention during the perioperative phase. This  
11 92 includes measuring the patient's body temperature, selecting methods for the prevention of  
12 93 unintended hypothermia, and implementing the selected insulation and warming interventions  
13 94 (17). Warming intervention measures include warming patients before surgery, during surgery,  
14 95 and after surgery by using passive insulation and active warming methods such as warmed cotton  
15 96 blankets, surgical draping, thermal garments, forced-air warming devices, electric warming  
16 97 blankets, and warmed fluids (18, 19).  
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23 98 Preventing heat loss and maintaining normal body temperature are important nursing care in an  
24 99 early phase of resuscitation as metabolic changes accompanied by injury cannot be corrected  
25 100 when patients are in hypothermic status (20). Nurses need to be cognizant of the risks associated  
26 101 with each perioperative phase of the patient in the prevention of hypothermia(21). Preserving a  
27 102 normal body temperature during the surgical experience enhances the patient's chance of  
28 103 preventing postoperative complications (22). Different evidence reported that maintenance of  
29 104 normal body temperature decreases the length of hospitalization by approximately up to 40%, the  
30 105 risk of surgical site infection by 64%, may prevent the costs of potential stay in the intensive  
31 106 care unit by \$1,000 and a prolonged hospital stay by \$465 per day, and also decreasing mortality  
32 107 rate by four folds (23-25).  
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41 108 If nurses do not have adequate knowledge and skill in the prevention of perioperative  
42 109 hypothermia, its occurrence is inevitable. Even if nurses' knowledge and practice are important  
43 110 in the prevention of perioperative hypothermia and its complications, available literature  
44 111 revealed that nurses had significant knowledge and practice gaps (15). Different socio-  
45 112 demographic and institutional factors which include age, marital status, educational level, work  
46 113 experience, presence of guidelines and risk assessment protocol, taking training, reading updated  
47 114 evidence, and job satisfaction affect nurses' knowledge and practice (2, 13, 26, 27).  
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3 115 In Ethiopia, there are no studies available regarding nurses' knowledge and practice on  
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5 116 perioperative hypothermia prevention. Therefore, the purpose of this study is to assess nurses'  
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7 117 knowledge, practice, and their determinant factors of perioperative hypothermia prevention in  
8  
9 118 Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia.

## 11 119 **Methods**

### 14 120 **Study design and period**

15 121 An institutional-based cross-sectional study was conducted in perioperative units/wards of five  
16  
17 122 referral hospitals from March 25 to May 20/2021.

### 19 123 **Study area**

21 124 The study was conducted in Northwest Amhara Regional State Referral Hospitals, Northwest  
22  
23 125 Ethiopia. Northwest Amhara is found in the northwestern part of Ethiopia. There are five  
24  
25 126 governmental referral hospitals in Northwest Amhara regional state namely University of  
26  
27 127 Gondar Comprehensive Specialized Referral Hospital (UoGCSRH), Felege Hiwot Referral  
28  
29 128 Hospital (FHRH), Tibebe Gion Specialized Referral Hospital (TGSRH), Debre Markos Referral  
30  
31 129 Hospital (DMRH), and Debre Tabor Comprehensive Referral Hospital (DTCRH). All hospitals  
32  
33 130 provide outpatient and inpatient services. The surgical department is one of the actively serving  
34  
35 131 departments giving emergency and elective surgery among the services given by the hospitals.  
36  
37 132 All five hospitals have different surgical units in their surgical department such as surgical  
38  
39 133 emergency, operation room, recovery ward, surgical ward, orthopedics ward, and surgical  
40  
41 134 intensive care unit (ICU). According to information obtained from the administrative offices of  
42  
43 135 these hospitals, there are 1682 nurses, who provide services. Among those 725 nurses (153 in  
44  
45 136 UoGCSRH, 220 in FHRH, 144 in TGSRH, 127 in DMRH, and 81 in DTCRH) are working in  
46  
47 137 our study unit (28-32). Nurses who are working in the perioperative unit provide different  
48  
49 138 hypothermia preventive activities like covering patients with linens and blankets, measuring  
50  
51 139 patients' temperature, warming intravenous fluids; adjusting room temperature, and so on.  
52  
53 140 Because preventing perioperative hypothermia is a crucial role for nurses.

### 51 141 **Source population**

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3 142 The source populations were all nurses who were working in the emergency, operation room,  
4 143 recovery ward, surgical ward, orthopedics ward, and surgical ICU of Northwest Amhara  
5 144 Regional State Referral Hospitals, Northwest Ethiopia.

### 145 **Study population**

11 146 The study population included nurses who were working in an emergency ward, operation room,  
12 147 recovery ward, surgical ward, orthopedics ward, and surgical ICU of UoGCSRH, DTCRH,  
13 148 DMRH, TGRH, and FHRH during the data collection period.

### 149 **Sample size and sampling procedure**

#### 150 **Sample size**

21 151 The sample size of the study was calculated using the formula for the estimation of a single  
22 152 population proportion and the assumptions were the proportion of knowledge and practice of  
23 153 nurses regarding hypothermia prevention was 50% (since there was no study conducted in our  
24 154 country), with 95% level of confidence and 5% margin of error. By using a z-value of 1.96 at  
25 155 95% CI the minimum sample size for this study was:

30 156 As:  $n = Z\alpha/2^2 * P (1-P) / d^2$

31 157 n = sample size

33 158 p = proportion of knowledge & practice of nurses on hypothermia prevention =0.5

35 159 d = maximum allowable error (margin of error) = 0.05

37 160 Z = value of standard normal distribution at 95% confidence level ( $z=1.96$ ).

39 161  $n = (1.96) (1.96) *(0.5) (1-0.5) / (0.05) (0.05) = 384$  subjects;

41 162  $\Rightarrow$  By adding a 10% allowance for non-response rate the total sample size was

42 163  $384+10\%=423$

#### 164 **Sampling procedure**

47 165 The study was performed on nurses who were working in the emergency surgical (including the  
48 166 trauma unit), operation room, recovery ward, surgical ward, orthopedics ward, and surgical ICU  
49 167 of Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia. A stratified  
50 168 sampling technique was employed to recruit the required participants for the study. First, the  
51 169 study participants are stratified from each hospital and working ward/unit and allocated the

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3 170 required sample for each stratum proportionally. According to all hospitals human resources, and  
4  
5 171 administration reports the total number of nurses who were working in these units or wards was  
6  
7 172 725. Based on the number of nurses working in each hospital, 423 samples were proportionally  
8  
9 173 allocated from 725 (from 153 - 89 in UoGCSRH, 144 - 84 in TGRH, 220 -128 in FHRH, 81 - 48  
10  
11 174 in DTRH, and 127 - 74 in DMRH). Finally, those participants were taken by lottery method of  
12  
13 175 simple random sampling technique from each sampling frame (Supplemental Figure)

#### 14 176 **Inclusion and exclusion criteria**

15  
16 177 All nurses who were working in the surgical emergency, operation room, recovery ward, surgical  
17  
18 178 ICU, surgical ward, and orthopedic ward of Northwest Amhara Regional State Referral  
19  
20 179 Hospitals, Northwest Ethiopia during the time of data collection were included in this study.  
21  
22 180 Matron and ward coordinator nurses were excluded because those nurses are primarily  
23  
24 181 responsible is coordinating, monitoring, and evaluating the staff nurses rather they doing routine  
25  
26 182 activities.

#### 26 183 **Operational definitions**

27  
28 184 **Knowledge:** Is theoretical or practical understanding of hypothermia and its prevention method  
29  
30 185 through education or experience. Based on this research the percentage scores were graded as  
31  
32 186 'poor', and 'good to determine the knowledge level.

33  
34 187 **Good knowledge:** If the study participants answer the knowledge questions above or equal to the  
35  
36 188 computed median they are considered as having good knowledge.

37  
38 189 **Poor knowledge:** If the study participants answered, the knowledge questions below the  
39  
40 190 computed median were considered as having poor knowledge.

41  
42 191 **Practice:** Activities acting by nurses to prevent hypothermia. Items in this category of the Likert  
43  
44 192 scale were coded as 0 to 2 for: never, sometimes, and always.

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46 193 **Good practice:** The study participants who answered above or equal to the computed median of  
47  
48 194 practice questions were considered as having good practice.

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50 195 **Poor practice:** The study participants who answered below the computed median of practice  
51  
52 196 questions were considered to have poor practice.

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3 197 **Job satisfaction:** When the total score for the job satisfaction questionnaire was greater than or  
4  
5 198 equal to the computed median, we said they were satisfied, and less than the computed median,  
6  
7 199 we said they were dissatisfied with the overall aspect of their work.

### 200 **Data collection instruments and procedure**

201 Data was collected by using a self-administered questionnaire which was adapted from  
202 guidelines of AORN and NICE perioperative hypothermia prevention, and other literature which  
203 involves 27 questions for knowledge and 14 questions for practice (13, 33-35), and 15 questions  
204 for Socio-demographic, institutional and other characteristics (2, 4, 13, 26, 27, 33, 36). Besides,  
205 three advisors who have experience in establishing through revision of content validity  
206 instruments were consulted to assess the questionnaire's validity. The questionnaires were  
207 prepared in the English language based on the study objectives, focusing on the background  
208 information of hypothermia and its prevention. Five BSc nurse staff who was working other than  
209 the study wards were recruited for data collection and two MSc holder nurses were recruited as a  
210 supervisor. Overall, the data collection process was coordinated and supervised by the principal  
211 investigator.

### 212 **Data quality control**

213 To ensure the quality of the collected data, data collectors and supervisors underwent one-day  
214 training on the purpose of the study and the data collection procedure. The questionnaire was  
215 additionally pretested at Woldia Comprehensive Referral Hospital with 5% of the sample size.  
216 Internal consistency was checked by computing Cronbach's  $\alpha$  for both dependent variables and  
217 job satisfaction questionnaires. The tests showed 0.81, 0.77, and 0.91 for knowledge, practice,  
218 and job satisfaction respectively. Supervisors and primary investigator conducted routine  
219 supervision to verify the consistency and completeness of the questionnaires that were filled out.  
220 Incomplete questionnaires were put in offices arranged for this purpose so that participants  
221 completed their questionnaires.

### 222 **Data processing and analysis**

223 After the data was checked for its consistency and completeness, data were entered into Epi Info  
224 version 7 and exported into SPSS version 25 for analysis. A frequency table was used to describe



225 the participant characteristics knowledge and practice scores. Multicollinearity was checked by  
 226 using the variance inflation factor and its values were between 1 and 10. Model adequacy was  
 227 checked by using the Hosmer-Lemeshow goodness of fit test and the model was fitted well  
 228 which indicates .856 and .993 for knowledge and practice respectively. Binary logistic regression  
 229 was used to determine the significant association between the independent and dependent  
 230 variables. Those independent variables, which are less than 0.2 in bivariate analysis, were  
 231 entered into multivariable logistic regressions. The association between the independent variable  
 232 and dependent variable was considered the significant if P-value was less than 0.05 from  
 233 multivariate logistic regression analysis.

### 234 **Patient and public involvement**

235 It was not appropriate or possible to involve patients or the public in the design, conduct, report,  
 236 or dissemination plans of our research because this study was done on Nurses.

## 237 **Results**

### 238 **Socio-demographic characteristics of the respondents**

239 A total of 423, with a response rate of 97.6% of study participants were involved in this study.  
 240 The median age (IQR) of the study participants was 29 (27, 32) years, ranging from 20-58 years  
 241 and almost half of the participants were under the age category between 26 to 30 years. Two  
 242 hundred thirteen (51.6%) of the participants were male, and 235(56.9%) were married. Out of  
 243 413 nurses, three-fourths of the respondents had a bachelor's degree (Table 1).

244 Table 1: Socio-demographic characteristics of nurses on perioperative hypothermia prevention in  
 245 Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021(N=413).

Variable	Response	Frequency (N=413)	Percentage (%)
<b>Sex</b>	Male	213	51.6
	Female	200	48.4
<b>Age</b>	≤ 25 years	53	12.8
	26-30	224	54.2
	31-35	86	20.8
	≥ 35	50	12.1

<b>Marital status</b>	Single	163	39.5
	Married	235	56.9
	Divorced	12	2.9
	Widowed	3	.7
<b>Educational status</b>	Diploma	59	14.3
	Degree	311	75.3
	Master	43	10.4
<b>Work experience</b>	≤ 5 years	157	38
	6-10	181	43.8
	11-15	57	13.8
	≥ 16	18	4.4
<b>Monthly salary(ETB)</b>	≤ 5000	42	10.2
	5001-7000	158	38.3
	7001-9000	172	41.6
	≥ 9001	41	9.9

246 *ETB- Ethiopian Birr*

## 247 **Institutional and job-related factors of the respondents**

248 From 413, 268(64.9%) of nurses did not take training about perioperative hypothermia  
 249 prevention. half of the respondents reported that they were reading or reviewing updated  
 250 evidence, and only 121(29.3%) of participants were notified of the presence of guidelines or  
 251 protocols in their working area. Out of the study participants, 268 (64.9%) and 342 (82.8%) had  
 252 a shortage of thermometers and warming materials respectively. From 413 study participants,  
 253 nearly half of 217 (52.5%) participants were satisfied with their jobs (Supplemental Table).

## 254 **Knowledge of nurses on hypothermia prevention**

255 The overall median knowledge score of the study participants on perioperative hypothermia  
 256 prevention was 18 with an IQR of (16, 21). In this study, 244 (59.1%) with 95% CI: (54.7, 63.7)  
 257 of the participants had good knowledge. Among a total of knowledge assessment questions,

258 359(86.9%) participants have correctly answered the statement about thermoregulation. Three-  
 259 fourths of the participants gave the correct answer of anesthetic drugs increase heat loss while  
 260 250(60.5) of the participants correctly answered the complications of hypothermia in surgical  
 261 patients. Only 83(20.1%) of the participants were correctly respond in the theatre room, the  
 262 patient's temperature should be measured every 30 minutes while in the recovery room, every 15  
 263 minutes (Table 2).

264 Table 2. Nurse's responses on knowledge of perioperative hypothermia prevention (N=413)

Statements about perioperative hypothermia prevention	True / False	Correct answer		Wrong answer /don't know	
		N	%	N	%
The internal environment of humans can be maintained by thermoregulation.	T*	359	86.9	54	13.1
PH at any time during the perioperative cycle is characterized as a core body temperature < 36 ° C.	T*	288	69.7	125	30.3
Anesthetic drugs decrease heat loss in surgical patients.	F**	311	75.3	102	24.7
Cold IV fluids and blood products increase heat loss.	T*	288	69.5	126	30.5
PH is not associated with complications such as changes in drug metabolism, healing complications, shivering, clotting defects, cardiac morbidity, and prolonged post-anesthetic recovery.	F**	250	60.5	163	39.5
To minimize post-operative complications, nurses should advise patients to bring along additional clothing to help them stay warm before surgery	T*	339	82.1	74	17.9
The pulmonary artery catheter, distal esophagus, urinary bladder, rectum, zero heat-flux are some of the sites for temperature measurements.	T*	174	42.1	239	57.9
Nurses should be well trained and knowledgeable about the use of both temperature recording and warming devices	T*	346	83.8	67	16.2
Forced-air warming devices, warm water circulating and conductive devices are not some of the devices for warming surgical patients	F**	241	58.4	172	41.6
The method for temperature monitoring should not be chosen based on the criteria for a procedure	F**	281	68	132	32
To ensure accurate information, the team takes the patient's temperature at 15- minute intervals using different measuring devices at different sites.	F**	138	33.4	275	66.6
Patients with temperature < 36.0°C undergoing anesthesia & those having a high risk of cardiovascular complications are at higher risk for IPH	T*	293	70.9	120	29.1
It is not necessary to measure patients' temperature in the hour before	F**	279	67.6	134	32.4

departing the ward since it will be measured at the theatre.

Except in urgent circumstances, preoperative patients with temperatures of < 36.0°C should be warmed for 30' by using active warming method	T*	284	68.8	129	31.2
---	----	-----	------	-----	------

Special attention should be given to the comfort of surgical patients having difficulties expressing themselves	T*	335	81.1	78	18.9
---	----	-----	------	----	------

The method for warming patients should be chosen based on planned procedure, patient position, IV access site, and warming equipment constraints.	T*	333	80.6	80	19.4
---	----	-----	------	----	------

Critical incidence reporting is not necessary for patients coming into the theatre with a temperature of less than 36.0°C.	F**	259	62.7	154	37.3
--	-----	-----	------	-----	------

Induction of anesthesia should not begin unless the patient's temperature is 36.0°C or above.	T*	203	49.2	210	50.8
---	----	-----	------	-----	------

The theatre's room temperature should be at least 21°C which can be adjusted to allow better working once active warming is initiated.	T*	273	66.1	140	33.9
--	----	-----	------	-----	------

All irrigation fluids used intraoperative should be warmed in a thermostatically controlled cabinet to a temperature of 38- 40°C.	T*	214	51.8	199	48.2
---	----	-----	------	-----	------

Fluid warming devices should be used to warm IV fluids (500mls or more) & blood products to 37°C	T*	260	63	153	37
--	----	-----	----	-----	----

Regardless of the temperatures of patients before leaving the ward, they should be warmed using active warming method once in the theatre	T*	256	62	157	38
---	----	-----	----	-----	----

The surgical patient should be well covered throughout surgery to conserve heat and only be exposed during surgical preparation.	T*	310	75.1	103	24.9
--	----	-----	------	-----	------

During the postoperative period, hypothermic patients should be warmed using AWM until they become warm before transferring them to the ward.	T*	348	84.3	65	15.7
---	----	-----	------	----	------

Patients should be provided with at least 1 cotton sheet, 2 blankets, or a duvet during the postoperative phase	T*	319	77.2	94	22.8
---	----	-----	------	----	------

While in the OR, the patients' temperature should be measured every 15 minutes and every 30 minutes while in the RR.	F**	83	20.1	330	79.9
--	-----	----	------	-----	------

The temperature of post-operative patients should be recorded on arrival in the ward and be documented as part of a routine 4-hour observation.	T*	337	81.6	76	18.4
---	----	-----	------	----	------

265 T\*-True statement, F\*\*-False statement, N- Number of participants.

## 266 Practice of nurses on hypothermia prevention

267 The overall median practice score of the study participants on perioperative hypothermia  
 268 prevention was 18 with an IQR of (14, 21). In this study, 208 (50.4%) with 95% CI: (45.5, 55) of  
 269 the participants had good practice. Among practice assessment questions, 258(62.5%) of the

respondents measured temperature as soon as the patient arrived, and 224(54.2%) of the respondents were always assessing the signs and symptoms of hypothermia. Nearly half of the respondents 214(51.8%) and 213(51.6%) were sometimes maintaining ambient room temperature according to guidelines and also applying warm intravenous, blood products, and irrigation fluids respectively. Among 413 participants, 185(44.8%) of the respondents were reported never using forced-air warming devices, warm water circulating devices, and conductive devices for warming surgical patients (Table 3).

Table 3. Nurse's responses on practice of perioperative hypothermia prevention (N=413)

Hypothermia prevention practices	Never		Some times		Always	
	N	%	N	%	N	%
Do you measure temperature as soon as the patient arrival?	21	5.1	134	32.4	258	62.5
Do you measure temperature regularly according to guidelines?	50	12.1	202	48.9	161	39
Do you warm intravenous, blood products, and irrigation fluids using warming devices before administering to patients?	112	27.1	213	51.6	88	21.3
Do you cover the mattress plastic sheet with dry linen before patient admission?	59	14.3	200	48.4	154	37.3
Do you use forced-air warming devices, warm water circulating devices, and conductive devices for warming patients?	185	44.8	170	41.2	58	14
Do you communicate your assessment findings on factors that could lead to hypothermia to all members of the perioperative team?	57	13.8	160	38.7	196	47.5
Do you advise patients to inform you when they feel cold during their hospitalization?	53	12.8	195	47.2	165	40
Do you develop and implement care plans for perioperative hypothermia prevention?	73	17.7	217	52.5	123	29.8
Do you document the site for temperature measurement in the patients' file?	63	15.3	156	37.8	194	47
Do you maintain ambient room temperature according to the guideline?	110	26.6	214	51.8	89	21.5
Do you assess patients for their risk for perioperative hypothermia?	41	9.9	202	48.9	170	41.2
Do you assess for signs and symptoms of hypothermia?	30	7.3	159	38.5	224	54.2
Do you advise patients to stay warm prior to surgery?	48	11.6	185	44.8	180	43.6
Do you include thermoregulation interventions and patient-related care to thermoregulation in your hand-over report	41	9.9	194	47	178	43.1

## 278 Factors associated with the level of knowledge on hypothermia prevention

279 In the binary logistic regression, ten of fifteen variables p-value of < 0.2 and were candidates for  
 280 multiple logistic regression. In multiple logistic regression, only three variables were  
 281 significantly associated with knowledge of perioperative hypothermia prevention. In this study,  
 282 being male [AOR = 1.61, 95% CI (1.02-2.53)], an educational level of degree and masters  
 283 [AOR = 2.50; 95% CI (1.25-5.00), 4.39; (1.45-13.20)] respectively, and took training on  
 284 perioperative hypothermia prevention [AOR = 3.68; 95% CI (2.14-6.33)] were significantly  
 285 associated with their knowledge (Table 4).

286 Table 4- Bi-variable and multivariable analysis of factors associated with knowledge of nurses  
 287 on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest  
 288 Ethiopia.

Variable	Knowledge of nurses		COR (95%CI)	P-value	AOR (95% CI)	P-value
	Good	Poor				
Sex						
Female	105	95	1		1	
Male	139	74	1.69(1.14-2.52)	.009	1.61(1.02-2.53)	.038**
Educational status						
Diploma	19	40	1		1	
Degree	191	120	3.35(1.85-6.05)	.000	2.50(1.25-5.00)	.010**
Master	34	9	7.95(3.18-19.8)	.000	4.39(1.45-13.2)	.008**
Hospital						
FHRH	67	59	1		1	
UoGCSRH	48	35	1.20(.69-2.11)	.314	1.18(.631-2.21)	.601
DMCRH	51	22	2.04(1.11-3.76)	.056	1.74(.863-3.49)	.118
DTCRH	33	14	2.08(1.01-4.25)	.046	2.16(.933-4.94)	.068
TGSRH	45	39	1.01(.58-1.77)	.955	1.20(.627-2.29)	.581

1							
2							
3							
4	Ward						
5	Emergency	52	51	1		1	
6	Recovery	31	8	3.8(1.59-9.05)	.003	2.24(.862-5.84)	.098
7	ICU	34	19	1.75(.88-3.46)	.106	1.48(.696-3.16)	.307
8	OR	67	35	1.87(1.07-3.29)	.028	1.51(.799-2.86)	.203
9	Orthopedics	26	20	1.27(.63-2.56)	.496	1.35(.641-3.02)	.402
10	Surgical	34	36	.92(.50-1.70)	.805	.850(.431-1.67)	.640
11	Monthly salary(ETB)						
12	≤ 5000	18	21	1		1	
13	5001-7000	90	74	1.41(.7-2.85)	.477	1.10 (.478-2.35)	.885
14	7001-9000	107	64	1.95(.96-3.93)	.075	.848(.492-2.49)	.802
15	≥ 9001	29	10	3.38(1.3-8.79)	.010	1.53(.507-4.67)	.447
16	Having guideline						
17	No	124	168	1		1	
18	Yes	75	46	1.37(.88-2.1)	.153	.848(.490-1.46)	.555
19	Took Training						
20	No	128	140	1		1	
21	Yes	116	29	4.37(2.72-7.01)	.000	3.68(2.14-6.33)	.000**
22	Reading updated evidence						
23	No	106	100	1		1	
24	Yes	138	69	1.88(1.26-2.80)	.002	1.32(.834-2.10)	.234
25	Shortage of thermometer						
26	Yes	148	120	1		1	
27	No	96	49	1.58(1.04-2.41)	.031	1.27(.776-2.08)	.325
28	Job satisfaction						
29	Unsatisfied	100	95	1		1	
30	Satisfied	144	74	1.84(1.24-2.74)	.002	1.38(.873-2.20)	.166

289 Variables that show significant association during multivariable logistic regression at \*\*p-value  
 290 <0.05, Hosmer and Lemeshow test P=.856, 1=Reference.

### 291 Factors associated with the level of practice on hypothermia prevention

292 In bivariate logistic regression analysis, eleven of sixteen variables were found to have  
 293 significant predictors at a p-value < 0.2 and were candidates for multiple logistic regression. In  
 294 multiple logistic regression only four variables were nurses' significant predictors for the  
 295 practice of nurses on hypothermia prevention at (P<0.05).

296 Nurses who were working in recovery and intensive care units [AOR = 2.87; 95% CI (1.08-7.58),  
 297 and 2.39; 95% CI (1.09-5.22)] respectively, having training related to hypothermia prevention  
 298 [AOR = 2.64; 95% CI (1.53-4.57)],satisfied with their job [AOR 2.15; 95% CI (1.34-3.43)], and  
 299 to have good knowledge of hypothermia [AOR 2.64; 95% CI (1.63-4.27)] were significantly  
 300 associated with their practice (Table 5)

301 Table 5- Bi-variable and multivariable analysis of factors associated with the practice of nurses  
 302 on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest  
 303 Ethiopia.

Variable	Practice of nurses		COR (95%CI)	P-value	AOR (95% CI)	P-value
	Good	Poor				
Educational status						
Diploma	16	43	1		1	
Degree	159	152	2.81(1.51-5.20)	.000	1.94(.902-4.20)	.089
Master	24	19	3.39(1.47-7.79)	.002	1.28(.411-4.00)	.669
Working ward						
Emergency	41	62	1		1	
Recovery	30	9	5.04(2.1-11.71)	.000	2.87(1.08-7.58)	.033**
ICU	34	19	2.70(1.36-5.37)	.004	2.39(1.09-5.22)	.029**
OR	59	43	2.07(1.18-3.62)	.010	1.63(.856-3.12)	.136
Orthopedics	20	26	1.16(.575-2.35)	.674	1.17(.527-2.62)	.693
Surgical	24	46	.78(.419-1.48)	.467	.657(.321-1.34)	.250
Work experience						
≤ 5 years	69	88	1		1	



6-10	95	86	1.4(.917-2.16)	.118	1.26(.713-2.23)	.424
11-15	32	25	1.63(.886-3.00)	.116	1.68(.735-3.86)	.217
≥ 16	12	6	2.55(.911-7.14)	.075	3.26(.85-12.44)	.083
Monthly salary(ETB)						
≤ 5000	17	25	1		1	
5001-7000	67	91	1.08(.542-2.16)	.822	1.01(.436-2.35)	.976
7001-9000	98	74	1.94(.987-3.86)	.057	1.26(.517-3.10)	.604
≥ 9001	26	15	2.54(1.05-6.17)	.038	1.05(.310-3.58)	.933
Having guidelines/ protocol						
No	131	161	1		1	
Yes	77	44	2.15(1.39-3.32)	.001	1.42(.824-2.47)	.205
Took training						
No	104	164	1		1	
Yes	104	41	4.00(2.58-6.19)	.000	2.64(1.53-4.57)	.001**
Reading updated evidence						
No	84	122	1		1	
Yes	124	83	2.17(1.46-3.21)	.000	1.37(.853-2.21)	.192
Constraint of thermometer						
Yes	123	145	1.67(1.11-2.51)	.014	1.10(.661-1.83)	.711
No	85	60	1		1	
Shortage of warming material						
Yes	166	176	1.53(.914-2.57)	.105	1.77(.923-3.39)	.086
No	42	29	1		1	
Job satisfaction						
Unsatisfied	71	124	1		1	
Satisfied	137	81	2.95(1.97-4.41)	.000	2.15(1.34-3.43)	.001**
Knowledge						
Good	157	87	4.17(2.74-6.35)	.000	2.64(1.63-4.27)	.000**
Poor	51	118	1		1	

304 Variables that show significant association during multivariable logistic regression at\*\* p-value  
305 <0.05, Hosmer and Lemeshow test P=.993, 1=Reference.

## 306 **Discussion**

307 The result of this study showed that the overall knowledge of nurses on perioperative  
308 hypothermia prevention was 59.1% with 95% CI (54.7, 63.7). This finding is higher than  
309 previous study conducted in Addis Ababa, Ethiopia(52.1%) (15). The possible reason might be  
310 due to socio-demographic differences, in the previous study most participants had a degree and  
311 diploma level of educational status and the study area was a single setting of trauma center while  
312 in the current study, greater than 10% of the participant had masters and study setting was  
313 multicenter. The other reason might be due to the difference in the time of the study because of  
314 the advancement of technology including updated evidence; educational programs were  
315 increased when the time is more and more recent. So, the participant might have to get more  
316 information regarding the topics. But this finding is much lower than those of studies conducted  
317 in Gambia (82%) (13), Turkey(77.5%) (4), Brazil (81.5%) (14), University of Iowa Hospitals  
318 and Clinics, America (71%) (37), Maryland, America (100%) (38), Ireland (39), and also as  
319 compare to NICE, AORN, and ASPAN guidelines of perioperative hypothermia prevention (3,  
320 17, 40). The possible justification for this difference might be due to the level of staff training,  
321 adopted recommended guidelines, socioeconomic status, and sample size. According to training  
322 on hypothermia prevention in this study, only a few nurses (35.1%) have been trained while in  
323 the comparison group except in Gambia, almost all participants were taking training on  
324 perioperative hypothermia prevention. In terms of using guidelines/protocol, in the studies  
325 conducted in America participants always used recommended guidelines and protocols while in  
326 this study only 29.3% of nurses were report as having guidelines/protocols. According to a  
327 difference in socioeconomic status of the participants as well as the study setting, we Ethiopians  
328 are in a low-income country compared to America, Brazil, and Ireland. This indirectly affects the  
329 quality of healthcare education as well as the healthcare setting. In terms of sample size the  
330 present study has a larger sample size (n=413) as compared to all listed above (in Gambia  
331 (n=53), Turkey (n=200), Brazil (n=21), University of Iowa Hospitals and Clinics, America n=30,  
332 Maryland, America n=19, Ireland n=198).

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3 333 In this study, the overall practice of nurses on perioperative hypothermia prevention was 50.4%  
4  
5 334 with 95% CI (45.5-55). This is consistent with the studies done in Addis Ababa, Ethiopia  
6  
7 335 (52.5%) and Durban, South Africa (46%) (15, 16). But this study is higher than the study done in  
8  
9 336 Gambia (19%) (13). The possible reason might be the difference in socio-demographic  
10  
11 337 characteristics like most of the participants in the Gambia had less than five years of experience,  
12  
13 338 and hadn't master's holder participants. On the other hand, the result of this study is much lower  
14  
15 339 when from NICE, AORN, and ASPAN recommendations guidelines (3, 17, 40). This  
16  
17 340 discrepancy could be due to the insufficient availability of warming material, measurement  
18  
19 341 material, and guidelines or protocol or it might be also an inadequate opportunity for frequent  
20  
21 342 training for nurses.

22  
23 343 Regarding the determinants of the level of knowledge on hypothermia prevention, this study has  
24  
25 344 found out that male nurses were found to have more knowledge of hypothermia prevention by  
26  
27 345 1.6 times as compared to females. The reason might be females have an extra workload, most  
28  
29 346 home activities such as bearing and taking care of children, cooking, washing, etc. are mostly  
30  
31 347 done by females (41). So due to being overloaded by other additional home activities, they might  
32  
33 348 not have enough time to scale up their knowledge.

34  
35 349 Nurses who had degrees and masters were more likely to have good knowledge of hypothermia  
36  
37 350 prevention by 2.5 and 4.4 times respectively as compared to those who had a diploma. This  
38  
39 351 finding is supported by studies conducted in Iran(26), and Brazil, educational interventions are  
40  
41 352 fundamental for nurses to guide their team and be the link of technical-scientific knowledge to  
42  
43 353 improve the quality of patient care (14). The possible reason might be that more educated  
44  
45 354 respondents have a higher opportunity of exposure to different courses directly or indirectly  
46  
47 355 related to the prevention of hypothermia.

48  
49 356 Those nurses who received training related to hypothermia prevention were 3.7 and 2.6 times  
50  
51 357 more likely to have good knowledge and practice of hypothermia prevention as compared to  
52  
53 358 their counterparts. This finding is supported by studies in Maryland, America(38), Brazil (42),  
54  
55 359 Iran (26), Turkey(4). The possible reason might be that training plays an important role in  
56  
57 360 improving the quality of patient care. The need to promote the effectiveness of in-site and off-  
58  
59 361 site training of nurses is an invaluable criterion. Training is necessary to update theoretical and  
60  
362 practical knowledge in every aspect of nursing education(41).

1  
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3 363 Another finding is nurses who were working in recovery and intensive care units were 2.9 and  
4 364 2.4 times more likely to have good practice respectively as compared to the nurses who were  
5  
6 365 working in the emergency ward. This finding is inconsistent with the study conducted in Turkey,  
7  
8 366 ICU nurses had more knowledge than nurses who were working in other wards but their practice  
9  
10 367 was not changing (4). The possible reason why Recovery and ICU nurses had better practice  
11  
12 368 might be patients admitted to Recovery and ICU wards need close follow-up because of their  
13  
14 369 physiological change/disturbance due to surgery or anesthesia effect. So working in two wards,  
15  
16 370 the nurses perform more activities, which maintain thermoregulation. Another reason might be  
17  
18 371 that the nurse-to-patient ratio is better than other wards, the standard is in recovery one to two,  
19  
20 372 ICU one to one, emergency one to three, and for surgical and orthopedics wards is one to six in  
21  
22 373 Ethiopia. The other reason might be better availability of resources like a thermometer, and  
23  
24 374 warming materials. Also might be most nurses who were working in those two wards took more  
25  
26 375 training than other nurses.

26 376 In this study, nurses who were satisfied with their jobs were 2.2 times more likely to have a good  
27  
28 377 level of practice as compared to those who were not satisfied. Job satisfaction of nurses is highly  
29  
30 378 important in building up employee interest and efficiency, as higher job satisfaction determines  
31  
32 379 better employee performance(43). Therefore, hospital administrators need to work on improving  
33  
34 380 working environments, so that nurses become safe and comfortable to result in a positive feeling  
35  
36 381 towards their job.

37 382 The other significant variable is nurses who have knowledge of hypothermia were 2.6 times  
38  
39 383 more likely to have a good practice as compared to those who hadn't knowledge of hypothermia  
40  
41 384 prevention. This study has supported studies conducted in Nigeria (44) and Textbook of Brunner  
42  
43 385 & Suddarth (45), AORN, surgical team awareness, education, and understanding of the effects of  
44  
45 386 hypothermia are necessary components to change how clinicians provide quality, cost-effective  
46  
47 387 patient care (46).

#### 388 **Strengths and Limitations of the Study**

50 389 A self-reported questionnaire measure of knowledge and practice of nurses on the prevention of  
51  
52 390 perioperative hypothermia is prone to social desirability bias and recall bias. Furthermore, this  
53  
54 391 study was not triangulated with a qualitative method. Despite these limitations, this study covers  
55  
56 392 a large setting (multicenter) area.

### 393 **Conclusion**

394 This study revealed that nurses' knowledge and practice regarding the prevention of perioperative  
395 hypothermia was found to be inadequate as compared to the recommended guidelines. Having a  
396 higher educational status, being male, and attending training showed a positive and significant  
397 association with good knowledge of perioperative hypothermia prevention. Whereas, factors  
398 contributing to practice were working ward, training, job satisfaction, and knowledge of nurses.  
399 Based on the findings of the study, we recommend to the Amhara regional health bureau and  
400 hospital administrators including ward coordinators in collaboration with other stakeholders:  
401 Improve sponsored educational opportunities, especially those nurses who have a diploma,  
402 promote and strengthen in-service training periodically and regularly, better to motivate those  
403 who have knowledge and practiced well, should fulfill the availability of resources like warming  
404 materials, thermometers, and updated guidelines/protocols, better to improve working  
405 environments so that nurses become safe and comfortable to result in a positive feeling towards  
406 their job. Researchers also should do other research for a strong recommendation by adding  
407 observational data collection methods.

### 408 **List of Abbreviation**

409 AOR: Adjusted Odd Ratio; AORN: Association of perioperative Register Nurses; ASPAN:  
410 American Society of PeriAnesthesia Nurses; CI: Confidence Interval; DMRH: Debre Markos  
411 Referral Hospital; DTCRH: Debre Tabor Comprehensive Referral Hospital; EMS: Emergency  
412 Medical Service; EPI INFO: Statistical Package for Epidemiological Information Analysis;  
413 FHRH: Felege Hiwot Referral Hospital; ICU: Intensive Care Unit; IPH: Inadvertent  
414 Perioperative Hypothermia; OR: Odds Ratio; OR: Operation Room; HP: Perioperative  
415 Hypothermia; PI: Principal Investigator; RR: Recovery Room; SPSS: Statistical Package of  
416 Social Science; T° c: Temperature In Degree Centigrade; TGSRH: Tibebe Gion Specialized  
417 Referral Hospital; UK: United Kingdom; UoGCSRH: University of Gondar Comprehensive  
418 Specialized Referral Hospital; USA: United States of America

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2  
3 419 **Declaration**

4  
5 420 **Ethical Approval and informed consent to participate**

6 421 The Institutional Ethical Review Board of the University of Gondar approved the study. Ethical  
7  
8 422 clearance was obtained from the board on behalf of the School of Nursing (Ref.  
9  
10 423 No. S/R/164/2/2021). Upon this clearance, additional written permission to conduct the study  
11  
12 424 was obtained from the manager of all five referral hospitals when after explaining the purpose,  
13  
14 425 the possible benefit of the study. Informed written consent was obtained from each respondent  
15  
16 426 before fulfilling the questionnaire. It was explained for the respondents that participated in the  
17  
18 427 study were voluntary and private information would be protected. The processes not identify  
19  
20 428 respondents by their name so; the process was done by keeping the privacy of the respondents.

21 429 **Consent to publish**

22 430 Not applicable

23  
24 431 **Availability of data and materials:**

25 432 All data relevant to the study are included in the article or uploaded as supplementary  
26  
27 433 information

28  
29 434 **Conflicts of Interest**

30 435 The authors declare that they have no conflicts of interest.

31  
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33  
34  
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36  
37 438 **Authors' contributions**

38  
39 439 Ashenafi Worku carried out the study starting from designing the study, analyzing, interpreting  
40  
41 440 data, and reviewing the manuscript. Bezenaw Yimer Mekkonen, Netsanet Tsegaye, and  
42  
43 441 Endalkachew Dellie participated in revising the measurement tool or questionnaire, proposal  
44  
45 442 writing, data analysis, interpretation, and commenting drafts of the paper and manuscript. All  
46  
47 443 authors involved in writing, reviewing and approving the final draft of the manuscript. All  
48  
49 444 authors read and approved the manuscript before submitting it to the journal for publication.

50  
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10 571 **Table legend:**

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13 572 **Supplemental Table:** Institutional and other related factors of the respondents on perioperative  
14 573 hypothermia prevention in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021  
15 574 (N=413).

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20 575 **Figure legend:**

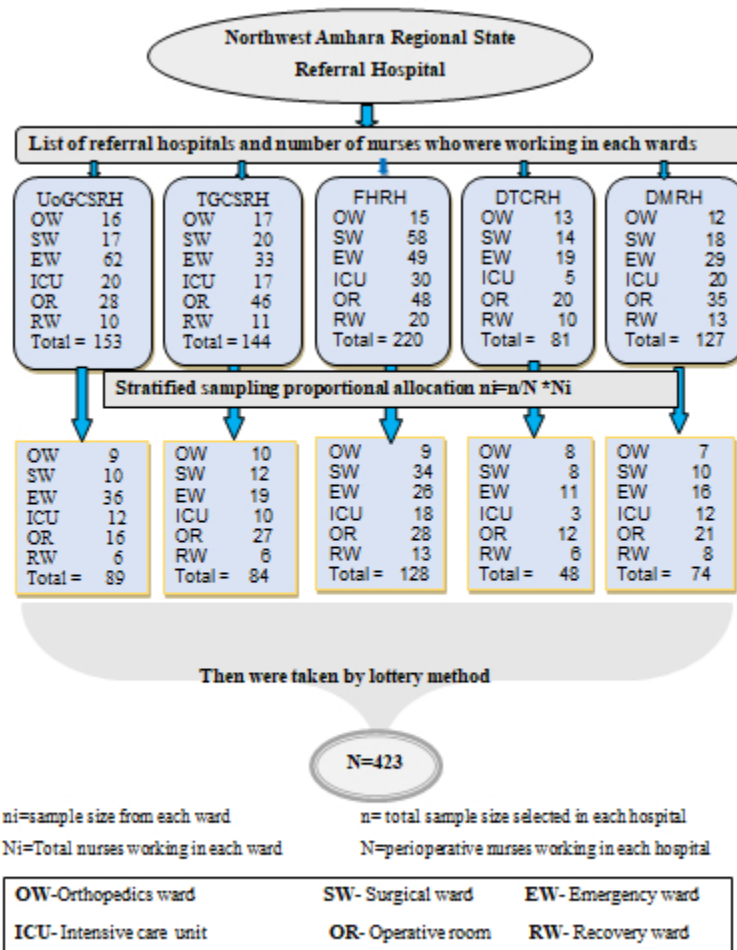
21 576 **Supplemental Figure:** Schematic presentation of sampling procedure of nurses' knowledge and  
22 577 practice, and associated factors on hypothermia prevention among surgical patients.

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Supplemental Table: Institutional and other related factors of the respondents on perioperative hypothermia prevention in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021 (N=413).

Variable	Response	Frequency (N=413)	Percentage (%)
Working place (hospital)	TGSRH	84	20.3
	UoGCSRH	83	20.1
	DMCRH	73	17.7
	DTCRH	47	11.4
	FHRH	126	30.5
Ward:	Emergency	103	24.9
	Recovery	39	9.4
	OR	102	24.7
	ICU	53	12.8
	Orthopedics ward	46	11.1
	Surgical ward	70	16.9
Daily working hours	≤ 8 hrs.	354	85.7
	≥9 hrs.	59	14.3
Training on hypothermia prevention	Yes	145	35.1
	No	268	64.9
Presence of protocol/guideline	Yes	121	29.3
	No	292	70.7
Reading updated evidence on hypothermia prevention	Yes	206	49.9
	No	207	50.1

Variable	Response	Frequency (N=413)	Percentage (%)
Availability of thermometer	Yes	145	35.1
	No	268	64.9
Constraints of warming material	Yes	342	82.8
	No	71	17.2
Shortage of blanket	Yes	166	40.2
	No	247	59.8
Shortage of linens	Yes	89	21.5
	No	324	78.5
Shortage of fluid warmer	Yes	132	32.0
	No	281	68.0
Shortage of air warmer/heater	Yes	212	51.3
	No	201	48.7
Shortage of warmer blanket	Yes	217	52.5
	No	196	47.5
Job satisfaction	Satisfied	217	52.5
	Dissatisfied	196	47.5



Supplemental Figure: Schematic presentation of sampling procedure of nurses' knowledge and practice, and associated factors on hypothermia prevention among surgical patients.

315x352mm (38 x 38 DPI)

**STROBE Statement—checklist of items that should be included in reports of observational studies**

	<b>Item No.</b>	<b>Recommendation</b>	<b>Page No.</b>	<b>Relevant text from manuscript</b>
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1	Line (1-3); An institution-based cross-sectional study was conducted for the title of Knowledge and Practice of nurses regarding Perioperative Hypothermia Prevention at Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia:
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2	Lines (27 – 50); Abstract
<b>Introduction</b>				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3 and 4	Lines (57 – 118); Introduction
Objectives	3	State-specific objectives, including any pre-specified hypotheses	4	Lines (116 – 118); This study aimed to assess nurses' knowledge, practice, and their determinant factors of perioperative hypothermia prevention in Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia.
<b>Methods</b>				
Study design	4	Present key elements of study design early in the paper	4	Lines (120 – 122); Institutional based cross-sectional study was conducted in perioperative units/wards of five referral hospitals from March 25-May 20/2021.
Setting	5	Describe the setting, locations, and relevant dates,	5	Lines (123 – 140); Study setting

		including periods of recruitment, exposure, follow-up, and data collection		
Participants	6	<p>(a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up</p> <p>Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls</p> <p>Cross-sectional study—Give the eligibility criteria and the sources and methods of selection of participants</p>	5,6, and 7	<p>Lines (141 – 148); Source and study population</p> <p>Lines (164 – 175); A total of 423 nurses were selected through a stratified random sampling technique, and data was collected from 413 nurses.</p> <p>Lines (176– 182); Inclusion and exclusion criteria (eligibility criteria)</p>
		<p>(b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed</p> <p>Case-control study—For matched studies, give matching criteria and the number of controls per case</p>	N/A	This was a cross-sectional study
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7	Lines (183 – 199); Operational definition of variables
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7 and 8	Lines (200 – 211); Data collection tools and procedures
Bias	9	Describe any efforts to address potential sources of bias	8	Lines (212–221); To maintain data quality training was given to data collectors and supervisors. The questionnaire was pretested among 5% of the sample size. Quality was also maintained by



				close monitoring of the procedure, and checking on the completeness of the data on-site by the responsibility of supervisors and the principal investigator.
Study size	10	Explain how the study size was arrived at	5 and 6	Lines (149–163); The sample size was determined by using a formula to estimate a single population proportion with the assumption of a 95% level of confidence, 50% proportion, and a 5% marginal error.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9	Lines (228–233); Binary logistic regression was used to determine the significant association between the independent and dependent variables. Those independent variables, which are less than 0.2 in bivariate analysis, were entered into multivariable logistic regressions. Association between the independent variable and dependent variable was considered significant if P-value was less than 0.05 from multivariate logistic regression analysis
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8	Lines (222–233); Statistical Analysis
		(b) Describe any methods used to examine subgroups and interactions	N/A	There were no subgroups
		(c) Explain how missing data were addressed	N/A	There was no missing data
		(d) Cohort study—If applicable, explain how loss to follow-up was addressed  Case-control study—If applicable, explain how matching of cases and controls was addressed  Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	6	Lines (164– 175); A total of 423 nurses were selected through a stratified random sampling technique, and data was collected from them

		(e) Describe any sensitivity analyses	N/A	
<b>Results</b>				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	N/A	This was a cross-sectional study with only one stage.
		(b) Give reasons for non-participation at each stage	N/A	
		(c) Consider use of a flow diagram	N/A	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, institutional, other) and information on exposures and potential confounders	9 and 10	Line (238-243); Table 1: Socio-demographic characteristics of the study participants on hypothermia prevention among perioperative patients in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021(N=413).  Line (248-254); <b>Institutional and job-related factors of the respondents</b> of the study participants
		(b) Indicate number of participants with missing data for each variable of interest	N/A	There was no missing data
		(c) Cohort study—Summarise follow-up time (eg, average and total amount)	N/A	This was a cross-sectional study
Outcome data	15*	Cohort study—Report numbers of outcome events or summary measures over time	N/A	This was cross-sectional study
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A	This was a cross-sectional study

		Cross-sectional study—Report numbers of outcome events or summary measures	10, 12, and 13	<p>Lines (257–258); In this study, 244 (59.1%) with 95% CI: (54.7, 63.7) of the participants had good knowledge</p> <p>Lines (269–270); In this study, 208 (50.4%) with 95% CI: (45.5, 55) of the participants had good practice.</p>
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10, 12, 13, and 20	<p>Lines (257-258); In this study, 244 (59.1%) with 95% CI: (54.7, 63.7) of the participants had good knowledge</p> <p>Lines (269-270); In this study, 208 (50.4%) with 95% CI: (45.5, 55) of the participants had a good practice.</p> <p>Lines (288-290); Table 4- Bi-variable and multivariable analysis of factors associated with knowledge of nurses on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia.</p> <p>Lines (303-305); Table 5- Bi-variable and multivariable analysis of factors associated with the practice of nurses on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia.</p>
		(b) Report category boundaries when continuous variables were categorized	N/A	There was no continuous variable.
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A	There was no estimate of relative risk.
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A	There was no sub groups and sensitivity analysis.
<b>Discussion</b>				

Key results	18	Summarise key results with reference to study objectives	19-22	Lines (308–389); Discussion
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	22	Lines (391–393); A self-reported questionnaire measure of knowledge and practice of nurses on the prevention of perioperative hypothermia is prone to social desirability bias and recall bias. Furthermore, this study was not triangulated with a qualitative method.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	19-22	Lines (308-394); Discussion and limitation and strength
Generalizability	21	Discuss the generalizability (external validity) of the study results	22	Lines (395-409); This study revealed that nurses' knowledge and practice regarding the prevention of perioperative hypothermia was found to be inadequate as compared to the recommended guidelines. Having higher educational status, being male, and attending training showed a positive and significant association with good knowledge of perioperative hypothermia prevention. Whereas, factors contributing to practice were working ward, training, job satisfaction, and knowledge of nurses.
<b>Other information</b>				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	24	Lines (439)-This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

# BMJ Open

## Knowledge and practice of nurses with respect to perioperative hypothermia prevention in the Northwest Amhara Regional State Referral Hospitals, Ethiopia: a cross-sectional study

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4 1 **Knowledge and practice of nurses with respect to perioperative**  
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7 2 **hypothermia prevention in the Northwest Amhara Regional State**  
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10 3 **Referral Hospitals, Ethiopia: a cross-sectional study**  
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21

## 22 Abstract

23 **Objectives** It has been reported that maintaining a normal body temperature among surgical  
24 patients can reduce the length of hospitalization by up to 40%, decrease the risk of surgical site  
25 infection by 64%, and reduce mortality fourfold. Nurses are primarily responsible for preventing  
26 the occurrence of hypothermia among surgical patients. This study assessed nurses' knowledge  
27 and practices with respect to perioperative hypothermia prevention in Northwest Ethiopia, and  
28 investigated the factors associated with good knowledge and practice.

29 **Design** Cross-sectional study.

30 **Setting** Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia, March 25 to  
31 May 20, 2021.

32 **Participants** 413 nurses working in the perioperative units of five referral hospitals.

33 **Outcome measures** Perioperative hypothermia prevention knowledge and practice among  
34 nurses.

35 **Results** Nearly three-fifths (59.1%; 95% CI: 54.7-63.7) of respondents had good knowledge and  
36 about half (50.4%; 95% CI: 45.5 - 55.0) good practice with respect to perioperative hypothermia  
37 prevention. Factors associated with nurses' knowledge of prevention of perioperative  
38 hypothermia included male sex (AOR: 1.61, 95% CI: 1.02-2.53), having a bachelor's degree  
39 (AOR: 2.50, 95% CI: 1.25-5.00), having a master's degree (AOR: 4.39, 95% CI: 1.45-13.20),  
40 and training participation (AOR: 3.68, 95% CI: 2.14-6.33). Factors associated with nurses'  
41 practice of prevention of perioperative hypothermia included working in recovery (AOR: 2.87,  
42 95% CI: 1.08-7.58) and intensive care units (AOR: 2.39, 95% CI: 1.09-5.22), training



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2  
3 43 participation (AOR: 2.64, 95% CI: 1.53-4.57), being satisfied with their job (AOR: 2.15, 95%  
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5 44 CI: 1.34-3.43), and having good knowledge (AOR: 2.64, 95% CI: 1.63-4.27).  
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8 45 **Conclusion** Nurses' knowledge and practice in the prevention of perioperative hypothermia were  
9  
10 46 inadequate. Hospital managers need to design and strengthen training programs and work to  
11  
12 47 enhance job satisfaction.  
13

14  
15 48 **Keywords:** Perioperative hypothermia, Ethiopia, Knowledge, Practice, Nurses.  
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### 18 49 **Strengths and limitations of this study**

- 20 50 ■ This cross-sectional study used a stratified random sampling method and had a high  
21  
22 51 response rate.
- 23  
24 52 ■ The study might be prone to social desirability bias, although this was minimized through  
25  
26 53 the use of a self-administered questionnaire.
- 27  
28 54 ■ The content validity of the questionnaire was not formally assessed using independent  
29  
30 55 experts.
- 31  
32 56 ■ The study results were not triangulated with findings from qualitative approaches, which  
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34 57 could have enhanced our findings.
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36 58 ■ The research findings may not be generalized beyond the limited study setting.  
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## 45 60 **INTRODUCTION**

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48 61 Hypothermia is a common health problem in patients having surgery that is characterized as a  
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50 62 body temperature below 36 °C (96.8°F), and it is usually caused by too much heat loss from cold  
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52 63 weather exposure, anesthetic effects, and the administration of cold intravenous or irrigation  
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54 64 fluids (1-3). Hypothermia decelerates all physiologic roles, including metabolic rate, mental  
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65 awareness, nerve conduction, neuromuscular reaction times, and cardiovascular and respiratory  
66 systems, disturbing patients' comfort and leading to longer hospitalizations, higher costs, and  
67 increasing mortality (1, 4).

68 Different studies conducted in different areas revealed that the magnitude of perioperative  
69 hypothermia in Brazil was 56.7%(5), in Australia, 74% (6), and in Turkey, the research hospital  
70 of Ankara and Trakya University Hospital were 78.6% and 63.3% respectively (7, 8). In other  
71 studies conducted in Thailand, the incidence of preoperative, intraoperative, and postoperative  
72 hypothermia was 0.4%, 73.5%, and 11.9% respectively (9). While the study was conducted in  
73 Germany to evaluate the hypothermia rates achieved with pre-warming and without pre-warming  
74 methods, the results revealed patients subjected to pre-warming showed an intraoperative  
75 hypothermia rate of 15.8% and a postoperative hypothermia rate of 5.1%. In comparison,  
76 patients without pre-warming showed an intraoperative hypothermia rate of 30.4% and  
77 a postoperative hypothermia rate of 12.4%. This means a 52% reduction in the intraoperative  
78 hypothermia rate and a 41% reduction in the postoperative hypothermia rate for patients who  
79 received pre-warming (10). Furthermore, in studies conducted in Ethiopia at Tikur Anbessa  
80 Specialized Hospital, the overall magnitude of preoperative, intraoperative, and postoperative  
81 hypothermia was 16.2%, 53.2%, and 31.3%, respectively (11). In contrast, at the University of  
82 Gondar Comprehensive Specialized Referral Hospital (UoGCSRH), preoperative, intraoperative,  
83 and postoperative hypothermia incidence was 23.4%, 49.7%, and 50.6%, respectively (12).  
84 However, available literature shows that nurses' knowledge and practice towards perioperative  
85 hypothermia prevention is low despite the high incidence, serious consequences, and availability  
86 of effective interventions to prevent and treat this frequent surgical complication (2, 13). In  
87 intervention studies conducted on perioperative hypothermia prevention in Brazil and Turkey,

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3 88 55.9% and 61.77% of nurses had good knowledge before training (4, 14). Another cross-  
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5 89 sectional study was done in Ethiopia regarding perioperative hypothermia prevention in trauma  
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7 90 patients; only 52.1% of nurses had good knowledge (15). In studies conducted in South Africa  
8  
9 91 and Gambia, 46% and 19% of nurses had good perioperative hypothermia prevention practices,  
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11 92 respectively (13, 16).

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15 93 According to the Association of Perioperative Register Nurses (AORN) Guidelines, nurses must  
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17 94 have knowledge and skills in preventing hypothermia during the perioperative phase. This  
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19 95 includes measuring the patient's body temperature, selecting methods to prevent unintended  
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21 96 hypothermia, and implementing the selected insulation and warming interventions (17).  
22  
23 97 Warming intervention measures include warming patients before, during, and after surgery using  
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25 98 passive insulation and active warming methods such as warmed cotton blankets, surgical  
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27 99 draping, thermal garments, forced-air warming devices, electric warming blankets, and warmed  
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29 100 fluids (18, 19).

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34 101 Preventing heat loss and maintaining a normal body temperature are essential nursing tasks in the  
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36 102 early resuscitation phase, as metabolic changes accompanied by injury cannot be corrected when  
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38 103 patients are hypothermic (20). Nurses need to be cognizant of the risks associated with each  
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40 104 perioperative phase of the patient in the prevention of hypothermia (21). Preserving a normal  
41  
42 105 body temperature during the surgical experience enhances the patient's chance of preventing  
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44 106 postoperative complications (22). Different evidence reported that maintenance of a normal body  
45  
46 107 temperature decreases the length of hospitalization by approximately up to 40%, the risk of  
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48 108 surgical site infection by 64%, may prevent the costs of potential stay in the intensive care unit  
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50 109 by \$1,000 and a prolonged hospital stay by \$465 per day, and also decreasing mortality rate by  
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52 110 fourfold (23-25).

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3 111 If nurses do not have adequate knowledge and skill in the prevention of perioperative  
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5 112 hypothermia, its occurrence is inevitable. Even if nurses' knowledge and practice are important  
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7 113 in preventing perioperative hypothermia and its complications, available literature revealed that  
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9 114 nurses had significant knowledge and practice gaps (13, 15). Different sociodemographic and  
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11 115 institutional factors affect nurses' knowledge and practice, such as age, marital status,  
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13 116 educational level, work experience, guidelines and risk assessment protocols, training, reading  
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15 117 updated evidence, and job satisfaction, affect nurses' knowledge and practice (2, 13, 15, 26, 27).  
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20 118 In Ethiopia, there is limited evidence regarding the knowledge and practice of nurses in  
21  
22 119 perioperative hypothermia prevention. Therefore, this study assessed nurses' knowledge and  
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24 120 practices with respect to perioperative hypothermia prevention in Northwest Amhara Regional  
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26 121 State Referral Hospitals, Northwest Ethiopia, and investigated the factors associated with good  
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28 122 knowledge and practice.  
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## 32 123 **METHODS**

### 33 34 35 124 **Study design and settings**

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38 125 An institutional-based cross-sectional study was conducted in five referral hospitals'  
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40 126 perioperative units or wards from March 25 to May 20, 2021.

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42 127 The study was conducted in Northwest Amhara Regional State Referral Hospitals, Northwest  
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44 128 Ethiopia. Northwest Amhara is found in the northwestern part of Ethiopia. There are five  
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46 129 governmental referral hospitals in Northwest Amhara regional state, namely the University of  
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48 130 Gondar Comprehensive Specialized Referral Hospital (UoGCSRH), Felege Hiwot Referral  
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50 131 Hospital (FHRH), Tibebe Gion Specialized Referral Hospital (TGSRH), Debre Markos Referral  
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3 132 Hospital (DMRH), and Debre Tabor Comprehensive Referral Hospital (DTCRH). All of these  
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5 133 hospitals provide both outpatient and inpatient services.  
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8 134 The surgical department is one of the actively serving departments that provide emergency and  
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10 135 elective surgery among hospital services. All five hospitals have different surgical units in their  
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12 136 surgical departments, such as surgical emergency, operation room, recovery ward, surgical ward,  
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14 137 orthopedics ward, and surgical intensive care unit (ICU). According to information obtained  
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16 138 from the administrative offices of these hospitals, 1682 nurses provide services. Among those,  
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18 139 725 nurses (153 in UoGCSRH, 220 in FHRH, 144 in TGSRH, 127 in DMRH, and 81 in  
19  
20 140 DTCRH) working in surgical departments (28-32). Nurses in the perioperative unit provide  
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22 141 different hypothermia preventive activities like covering patients with linens and blankets,  
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24 142 measuring patients' temperatures, warming intravenous fluids, adjusting room temperature, and  
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26 143 so on because preventing perioperative hypothermia is crucial for nurses.  
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## 32 **Participants**

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34 145 All nurses working in the emergency ward, operation room, recovery ward, surgical ward,  
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36 146 orthopedics ward, and surgical ICU of Northwest Amhara Regional State Referral Hospitals  
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38 147 were the source populations. Whereas nurses who were working in an emergency ward,  
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40 148 operation room, recovery ward, surgical ward, orthopedics ward, and surgical ICU of  
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42 149 UoGCSRH, DTCRH, DMRH, TGRH, and FHRH during the data collection period were the  
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44 150 study population.  
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49 151 All nurses working in the surgical emergency, operating room, recovery ward, surgical ICU,  
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51 152 surgical ward, and orthopedic ward of Northwest Amhara Regional State Referral Hospitals,  
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53 153 Northwest Ethiopia, were included in this study. Whereas matron and ward coordinator, nurses  
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3 154 were excluded because those nurses are primarily responsible for coordinating, monitoring, and  
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5 155 evaluating the staff nurses rather than doing routine activities.  
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## 8 156 **Sample size and sampling procedure**

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11 157 The sample size was calculated using the single population proportion formula ( $n = Z\alpha/2^2 * P(1 -$   
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13 158  $P) / d^2$ ). A 50% proportion of nurses' knowledge and practice on hypothermia prevention, 95%  
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15 159 confidence level, and 5% expected margin of error (d) were used. By considering a 10% non-  
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17 160 response rate, the final sample becomes 423.  
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20 161 The study participants were recruited using a stratified sampling technique. Initially, the study  
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22 162 participants are stratified by hospital and working ward or unit, and the required sample for each  
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24 163 stratum is allocated proportionally. According to all hospitals' human resources and  
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26 164 administration reports, the total number of nurses working in these units or wards was 725. The  
27  
28 165 calculated sample size was then proportionally allocated to each hospital according to the  
29  
30 166 number of nurses working in the respective departments or wards (i.e. from 153, 89 in  
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32 167 UoGCSRH, from 144, 84 in TGRH, from 220, 128 in FHRH, from 81, 48 in DTRH, and from  
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34 168 127, 74 nurses in DMRH). Finally, study participants were chosen using a simple random  
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36 169 sampling technique from each sampling frame (Supplemental Figure).  
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## 41 170 **Variables and measurements**

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44 171 **Knowledge** of nurses on hypothermia prevention was assessed using twenty-seven questions  
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46 172 derived from the association of perioperative register nurse guidelines and literature (3, 13, 21).  
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48 173 If the study participants answered the knowledge questions above or were equal to the computed  
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50 174 median score, they were considered to have good knowledge.  
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3 175 **Practice** of nurses on hypothermia prevention is activities performed by nurses to prevent  
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5 176 hypothermia. It was measured by fourteen items with Likert scale containing three response  
6  
7 177 options with a code of 0 = never, sometimes, = 1, and always = 2 (3, 13, 15). Participants who  
8  
9 178 answered above or equal to the computed median of practice questions were considered to have  
10  
11 179 good practice.

12  
13  
14 180 **Job satisfaction** is the nurses' degree of negative or positive views about their job or job  
15  
16 181 experience. It was measured using twenty-seven items of a five-point Likert scale (1 = strongly  
17  
18 182 disagree to 5 = strongly agree) (33). When the total score for the job satisfaction questionnaire  
19  
20 183 was greater than or equal to the computed median, we said they were satisfied.

## 21 184 **Data collection instruments and procedure**

22  
23  
24 185 A self-administered structured questionnaire was used to collect the data. The questionnaires  
25  
26 186 were developed based on AORN and NICE perioperative hypothermia prevention guidelines and  
27  
28 187 other literature (3, 13, 15, 21, 34, 35). In addition to the outcome variable, the tool contains  
29  
30 188 sociodemographic, institutional, and other factors (13, 15, 26, 27, 33, 36) (Supplemental File).  
31  
32 189 Five BSc nurses working outside the study wards and two MSc holder nurses were recruited for  
33  
34 190 the data collection and supervision, respectively. Overall, the principal investigator coordinated  
35  
36 191 and supervised the data collection process.

## 37 192 **Data quality control**

38  
39 193 To assure the quality of the data, the questionnaire was first prepared in English, then translated  
40  
41 194 to Amharic (local language), and then translated back to English to check its consistency. One-  
42  
43 195 day training on the purpose of the study and the data collection procedure was provided to the  
44  
45 196 data collectors and supervisors. Additionally, the tool was pretested at Woldia Comprehensive  
46  
47 197 Referral Hospital with 5% of the sample size. For the dependent variable and job satisfaction

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2  
3 198 questionnaires, internal consistency was checked using Cronbach's alpha test, and its values were  
4  
5 199 in the acceptable range with a minimum value of 0.77. Supervisors and primary investigators  
6  
7  
8 200 conducted routine supervision to verify the consistency and completeness of the questionnaires  
9  
10 201 that were filled out.

## 13 202 **Data processing and analysis**

16 203 After the data was checked for consistency and completeness, data were entered into Epi Info  
17  
18 204 version 7 and exported into SPSS version 25 for analysis. A frequency table described the  
19  
20  
21 205 participant's characteristics, knowledge, and practice scores. Multicollinearity among the  
22  
23 206 dependent variables was assessed using the variance inflation factor, and its values were between  
24  
25  
26 207 1 and 10. Model adequacy was checked using the Hosmer-Lemeshow goodness of fit test, and  
27  
28 208 the model was fitted well, indicating 0.856 and 0.993 for knowledge and practice, respectively.  
29  
30 209 Binary logistic regression was used to determine the significant association between the  
31  
32 210 independent and dependent variables. Those independent variables, less than 0.2 in bivariable  
33  
34  
35 211 analysis, were entered into multivariable logistic regressions. The association between the  
36  
37 212 independent and dependent variables was considered significant if the P-value was less than 0.05  
38  
39 213 from multivariate logistic regression analysis. AOR with 95% CI and a p-value of < 0.05 were  
40  
41  
42 214 used to declare associated factors with the knowledge and practice of nurses on hypothermia  
43  
44 215 prevention.

## 47 216 **Patient and public involvement**

50 217 None.

## 53 218 **RESULTS**



## 219 Sociodemographic characteristics of the respondents

220 In the present study, 413 nurses responded to the self-administered questionnaires with a  
 221 response rate of 97.6%. The study participants' median age (IQR) was 29 (27, 32) years. Above  
 222 average, 213 (51.6%) participants were male, and the majority, 235(56.9%) were married.  
 223 Regarding their educational status, nearly three-fourths of the respondents had a bachelor's  
 224 degree (Table 1).

225 **Table 1.** Sociodemographic characteristics of nurses on perioperative hypothermia prevention in  
 226 Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021(N=413)

Variable	Response	Frequency (N=413)	Percentage (%)
<b>Sex</b>	Male	213	51.6
	Female	200	48.4
<b>Age</b>	≤ 25 years	53	12.8
	26-30	224	54.2
	31-35	86	20.8
	≥ 35	50	12.1
<b>Marital status</b>	Single	163	39.5
	Married	235	56.9
	Divorced	12	2.9
	Widowed	3	.7
<b>Educational status</b>	Diploma	59	14.3
	Degree	311	75.3
	Master	43	10.4
<b>Work experience</b>	≤ 5 years	157	38

	6-10	181	43.8
	11-15	57	13.8
	≥ 16	18	4.4
<b>Monthly salary(ETB)</b>	≤ 5000	42	10.2
	5001-7000	158	38.3
	7001-9000	172	41.6
	≥ 9001	41	9.9

227 ETB= Ethiopian Birr.

## 228 **Institutional and job-related factors**

229 From 413, 268(64.9%) of nurses did not receive training on perioperative hypothermia  
 230 prevention. Half of the respondents reported reading or reviewing updated evidence, and only  
 231 121(29.3%) participants were notified of guidelines or protocols in their working area. Majority  
 232 of study participants, 268 (64.9%) and 342 (82.8%) had a thermometers and warming materials  
 233 shortage, respectively. Nearly half, 217 (52.5%) of the participants were satisfied with their jobs  
 234 (Supplemental Table).

## 235 **Knowledge of nurses on hypothermia prevention**

236 The overall knowledge of nurses on perioperative hypothermia prevention was 59.1% (95% CI:  
 237 54.7-63.7), the median knowledge score was 18 (IQR: 16, 21). Among a total of knowledge  
 238 assessment questions, 359(86.9%) participants correctly answered the statement about  
 239 thermoregulation, while 250(60.5) answered the complications of hypothermia in surgical  
 240 patients. Only 83(20.1%) of the participants correctly responded in the theatre room; the patient's  
 241 temperature should be measured every 30 minutes, while in the recovery room, every 15 minutes  
 242 (Table 2).

243 **Table 2.** Nurse's responses on knowledge of perioperative hypothermia prevention (N=413)

Statements about perioperative hypothermia prevention	True / False	Correct answer		Wrong answer/I don't know	
		N	%	N	%
The internal environment of humans can be maintained by thermoregulation.	T*	359	86.9	54	13.1
PH during the perioperative cycle is characterized as a core body temperature < 36 ° C.	T*	288	69.7	125	30.3
Anesthetic drugs decrease heat loss in surgical patients.	F**	311	75.3	102	24.7
Cold IV fluids and blood products increase heat loss.	T*	288	69.5	126	30.5
PH is not associated with complications such as changes in drug metabolism, healing complications, shivering, clotting defects, cardiac morbidity, and prolonged post-anesthetic recovery.	F**	250	60.5	163	39.5
To minimize postoperative complications, nurses should advise patients to bring along additional clothing to help them stay warm before surgery	T*	339	82.1	74	17.9
The pulmonary artery catheter, distal esophagus, urinary bladder, rectum, and zero heat-flux are some of the sites for temperature measurements.	T*	174	42.1	239	57.9
Nurses should be well-trained and knowledgeable about the use of both temperature recording and warming devices	T*	346	83.8	67	16.2
Forced-air warming devices, warm water circulating and conductive devices are not some of the devices for warming surgical patients	F**	241	58.4	172	41.6
The method for temperature monitoring should not be chosen based on the criteria for a procedure	F**	281	68	132	32
To ensure accurate information, the team takes the patient's temperature at 15-minute intervals using different measuring devices at different sites.	F**	138	33.4	275	66.6
Patients with a temperature < 36.0°C undergoing anesthesia & and those having a high risk of cardiovascular complications are at higher risk for IPH	T*	293	70.9	120	29.1
Measuring patients' temperature an hour before departing the ward is unnecessary since it will be measured at the theatre.	F**	279	67.6	134	32.4
Except in urgent circumstances, preoperative patients with temperatures of < 36.0°C should be warmed for 30' by using the active warming method	T*	284	68.8	129	31.2
Special attention should be given to the comfort of surgical patients having difficulties expressing themselves	T*	335	81.1	78	18.9
The method for warming patients should be chosen based on the planned procedure, patient position, IV access site, and warming equipment constraints.	T*	333	80.6	80	19.4

Critical incidence reporting is unnecessary for patients entering into the theatre with a temperature of less than 36.0°C.	F**	259	62.7	154	37.3
Induction of anesthesia should not begin unless the patient's temperature is 36.0°C or above.	T*	203	49.2	210	50.8
The theatre's room temperature should be at least 21°C which can be adjusted to allow better working once active warming is initiated.	T*	273	66.1	140	33.9
All intraoperative irrigation fluids should be warmed in a thermostatically controlled cabinet to 38- 40°C.	T*	214	51.8	199	48.2
Fluid warming devices should be used to warm IV fluids (500 mls or more) & and blood products to 37°C	T*	260	63	153	37
Regardless of patients' temperatures before leaving the ward, they should be warmed using active warming method once in the theatre	T*	256	62	157	38
The surgical patient should be well covered throughout surgery to conserve heat and only be exposed during surgical preparation.	T*	310	75.1	103	24.9
During the postoperative period, hypothermic patients should be warmed using AWM until they become warm before being transferred to the ward.	T*	348	84.3	65	15.7
Patients should be provided with at least one cotton sheet, two blankets, or a duvet during the postoperative phase	T*	319	77.2	94	22.8
While in the OR, the patient's temperature should be measured every 15 minutes and every 30 minutes while in the RR.	F**	83	20.1	330	79.9
The temperature of postoperative patients should be recorded on arrival in the ward and documented as part of a routine 4-hour observation.	T*	337	81.6	76	18.4

244 T\*-True statement, F\*\*-False statement, N- Number of participants.

## 245 Practice of nurses on hypothermia prevention

246 The overall median practice score of nurses on perioperative hypothermia prevention was 18  
 247 (IQR: 14, 21), and their overall practice in hypothermia prevention was 50.4% (95% CI: 45.5 -  
 248 55.0). Among practice assessment questions, 258(62.5%) of the respondents measured  
 249 temperature as soon as the patient arrived, and 224(54.2%) always assessed hypothermia's signs  
 250 and symptoms. Nearly half of the respondents, 213(51.6%) sometimes applied warm  
 251 intravenous, blood products, and irrigation fluids. About 185(44.8%) respondents reported never

252 using forced-air warming devices, warm water circulating devices, and conductive devices for  
 253 warming surgical patients (Table 3).

254 **Table 3.** Nurse's responses on the practice of perioperative hypothermia prevention (N=413)

Hypothermia prevention practices	Never		Some times		Always	
	N	%	N	%	N	%
Do you measure temperature as soon as the patient arrives?	21	5.1	134	32.4	258	62.5
Do you measure temperature regularly according to guidelines?	50	12.1	202	48.9	161	39
Do you warm intravenous, blood products, and irrigation fluids using warming devices before administering them to patients?	112	27.1	213	51.6	88	21.3
Do you cover the mattress plastic sheet with dry linen before patient admission?	59	14.3	200	48.4	154	37.3
Do you use forced-air warming, warm water circulating devices, and conductive devices for warming patients?	185	44.8	170	41.2	58	14
Do you communicate your assessment findings on factors that could lead to hypothermia to all members of the perioperative team?	57	13.8	160	38.7	196	47.5
Do you advise patients to inform you when they feel cold during their hospitalization?	53	12.8	195	47.2	165	40
Do you develop and implement care plans for perioperative hypothermia prevention?	73	17.7	217	52.5	123	29.8
Do you document the site for temperature measurement in the patient's file?	63	15.3	156	37.8	194	47
Do you maintain ambient room temperature according to the guidelines?	110	26.6	214	51.8	89	21.5
Do you assess patients for their risk for perioperative hypothermia?	41	9.9	202	48.9	170	41.2
Do you assess for signs and symptoms of hypothermia?	30	7.3	159	38.5	224	54.2
Do you advise patients to stay warm before surgery?	48	11.6	185	44.8	180	43.6
Do you include thermoregulation interventions and patient-related care to thermoregulation in your hand-over report	41	9.9	194	47	178	43.1

### 255 **Factors associated with the level of knowledge on hypothermia prevention**

256 In the binary logistic regression, ten of fifteen variables had a p-value of < 0.2 and were  
 257 candidates for multiple logistic regression. In multiple logistic regression, only three variables  
 258 were significantly associated with knowledge of perioperative hypothermia

259 prevention. Accordingly, being male [AOR = 1.61, 95% CI (1.02-2.53)], an educational level of  
 260 degree and master [AOR = 2.50; 95% CI (1.25-5.00), 4.39; (1.45-13.20)] respectively, and taking  
 261 training on perioperative hypothermia prevention [AOR = 3.68; 95% CI (2.14-6.33)] were  
 262 significantly associated with their knowledge (Table 4).

263 **Table 4.** Bi-variable and multivariable analysis of factors associated with nurses' knowledge in  
 264 perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia

Variable	Knowledge of nurses		COR (95%CI)	P-value	AOR (95% CI)	P-value
	Good	Poor				
Sex						
Female	105	95	1		1	
Male	139	74	1.69(1.14-2.52)	.009	1.61(1.02-2.53)	.038**
Educational status						
Diploma	19	40	1		1	
Degree	191	120	3.35(1.85-6.05)	.000	2.50(1.25-5.00)	.010**
Master	34	9	7.95(3.18-19.8)	.000	4.39(1.45-13.2)	.008**
Hospital						
FHRH	67	59	1		1	
UoGCSRH	48	35	1.20(.69-2.11)	.314	1.18(.631-2.21)	.601
DMCRH	51	22	2.04(1.11-3.76)	.056	1.74(.863-3.49)	.118
DTCRH	33	14	2.08(1.01-4.25)	.046	2.16(.933-4.94)	.068
TGSRH	45	39	1.01(.58-1.77)	.955	1.20(.627-2.29)	.581
Ward						
Emergency	52	51	1		1	

Recovery	31	8	3.8(1.59-9.05)	.003	2.24(.862-5.84)	.098
ICU	34	19	1.75(.88-3.46)	.106	1.48(.696-3.16)	.307
OR	67	35	1.87(1.07-3.29)	.028	1.51(.799-2.86)	.203
Orthopedics	26	20	1.27(.63-2.56)	.496	1.35(.641-3.02)	.402
Surgical	34	36	.92(.50-1.70)	.805	.850(.431-1.67)	.640
Monthly salary(ETB)						
≤ 5000	18	21	1		1	
5001-7000	90	74	1.41(.7-2.85)	.477	1.10 (.478-2.35)	.885
7001-9000	107	64	1.95(.96-3.93)	.075	.848(.492-2.49)	.802
≥ 9001	29	10	3.38(1.3-8.79)	.010	1.53(.507-4.67)	.447
Having guideline						
No	124	168	1		1	
Yes	75	46	1.37(.88-2.1)	.153	.848(.490-1.46)	.555
Took Training						
No	128	140	1		1	
Yes	116	29	4.37(2.72-7.01)	.000	3.68(2.14-6.33)	.000**
Reading updated evidence						
No	106	100	1		1	
Yes	138	69	1.88(1.26-2.80)	.002	1.32(.834-2.10)	.234
Shortage of thermometer						
Yes	148	120	1		1	
No	96	49	1.58(1.04-2.41)	.031	1.27(.776-2.08)	.325
Job satisfaction						
Unsatisfied	100	95	1		1	
Satisfied	144	74	1.84(1.24-2.74)	.002	1.38(.873-2.20)	.166

265 \*\*Statistically significant at p-value <0.05.

266

## 267 **Factors associated with the level of practice on hypothermia prevention**

268 In bivariate logistic regression analysis, eleven of sixteen variables were found to have  
 269 significant predictors at a p-value < 0.2 and were candidates for multiple logistic regression. In  
 270 multiple logistic regression, only four variables were significantly associated with the practice of  
 271 nurses on hypothermia prevention at (P<0.05).

272 Nurses who were working in recovery and intensive care units [AOR = 2.87; 95% CI (1.08-7.58),  
 273 and 2.39; 95% CI (1.09-5.22)] respectively, having training related to hypothermia prevention  
 274 [AOR = 2.64; 95% CI (1.53-4.57)], satisfied with their job [AOR 2.15; 95% CI (1.34-3.43)], and  
 275 good knowledge on hypothermia [AOR 2.64; 95% CI (1.63-4.27)] were significantly associated  
 276 with their practice (Table 5).

277 **Table 5.** Bi-variable and multivariable analysis of factors associated with the practice of nurses  
 278 on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest  
 279 Ethiopia

Variable	Practice of nurses		COR (95%CI)	P-value	AOR (95% CI)	P-value
	Good	Poor				
Educational status						
Diploma	16	43	1		1	
Degree	159	152	2.81(1.51-5.20)	.000	1.94(.902-4.20)	.089
Master	24	19	3.39(1.47-7.79)	.002	1.28(.411-4.00)	.669
Working ward						



Emergency	41	62	1		1	
Recovery	30	9	5.04(2.1-11.71)	.000	2.87(1.08-7.58)	.033**
ICU	34	19	2.70(1.36-5.37)	.004	2.39(1.09-5.22)	.029**
OR	59	43	2.07(1.18-3.62)	.010	1.63(.856-3.12)	.136
Orthopedics	20	26	1.16(.575-2.35)	.674	1.17(.527-2.62)	.693
Surgical	24	46	.78(.419-1.48)	.467	.657(.321-1.34)	.250
Work experience						
≤ 5 years	69	88	1		1	
6-10	95	86	1.4(.917-2.16)	.118	1.26(.713-2.23)	.424
11-15	32	25	1.63(.886-3.00)	.116	1.68(.735-3.86)	.217
≥ 16	12	6	2.55(.911-7.14)	.075	3.26(.85-12.44)	.083
Monthly salary(ETB)						
≤ 5000	17	25	1		1	
5001-7000	67	91	1.08(.542-2.16)	.822	1.01(.436-2.35)	.976
7001-9000	98	74	1.94(.987-3.86)	.057	1.26(.517-3.10)	.604
≥ 9001	26	15	2.54(1.05-6.17)	.038	1.05(.310-3.58)	.933
Having guidelines/ protocol						
No	131	161	1		1	
Yes	77	44	2.15(1.39-3.32)	.001	1.42(.824-2.47)	.205
Took training						
No	104	164	1		1	
Yes	104	41	4.00(2.58-6.19)	.000	2.64(1.53-4.57)	.001**
Reading updated evidence						
No	84	122	1		1	
Yes	124	83	2.17(1.46-3.21)	.000	1.37(.853-2.21)	.192
Constraint of thermometer						
Yes	123	145	1.67(1.11-2.51)	.014	1.10(.661-1.83)	.711
No	85	60	1		1	
Shortage of warming material						

Yes	166	176	1.53(.914-2.57)	.105	1.77(.923-3.39)	.086
No	42	29	1		1	
Job satisfaction						
Unsatisfied	71	124	1		1	
Satisfied	137	81	2.95(1.97-4.41)	.000	2.15(1.34-3.43)	.001**
Knowledge						
Good	157	87	4.17(2.74-6.35)	.000	2.64(1.63-4.27)	.000**
Poor	51	118	1		1	

280 \*\*Statistically significant at p-value <0.05.

## 281 DISCUSSION

282 This study showed that the overall knowledge of nurses on perioperative hypothermia prevention  
 283 was 59.1%. This finding is higher than the result of a study done in Ethiopia (52.1%) (15). The  
 284 possible reason might be due to sociodemographic differences. In the previous study, most  
 285 participants had a degree and diploma level of educational status, and the study area was a single  
 286 trauma center setting. In contrast, in the current study, more than 10% of the participants had  
 287 masters, and the study setting was multicenter. The other reason might be the difference in the  
 288 time of the study because of the advancement of technology, including updated evidence;  
 289 educational programs were increased when the time was more recent. So, the participant might  
 290 have to get more information regarding the topics.

291 However, this finding is much lower than those of studies conducted in Gambia (82%) (13),  
 292 Turkey (77.5%) (4), Brazil (81.5%) (14), the University of Iowa Hospitals and Clinics, America  
 293 (71%) (37), Maryland, America (100%) (38), Ireland (39). Besides, our study finding is lower  
 294 than the NICE, AORN, and ASPAN guidelines for perioperative hypothermia prevention (3, 17,  
 295 21). The possible justification for this difference might be due to the level of staff training,

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2  
3 296 adopted recommended guidelines, socioeconomic status, and sample size. According to training  
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5 297 on hypothermia prevention in this study, only a few nurses (35.1%) have been trained, while in  
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7 298 the comparison group, except in Gambia, almost all participants were received training on  
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9 299 perioperative hypothermia prevention. In terms of using guidelines or protocols, in the studies  
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11 300 conducted in America, participants always used recommended guidelines and protocols, while in  
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13 301 this study only 29.3% of nurses were reported as having guidelines or protocols. Regarding the  
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15 302 difference in socioeconomic status of the participants and the study setting, we Ethiopians are in  
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17 303 a low-income country compared to America, Brazil, and Ireland. This indirectly affects the  
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19 304 quality of healthcare education and the healthcare setting. In terms of sample size, the present  
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21 305 study has a larger sample size (n = 413) compared to all the aforementioned studies (in Gambia  
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23 306 (n = 53), Turkey (n = 200), Brazil (n = 21), the University of Iowa Hospitals and Clinics,  
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25 307 America (n = 30), Maryland (n = 19), and Ireland (n = 198).

26  
27 308 In this study, the overall practice of nurses on perioperative hypothermia prevention was 50.4%.  
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29 309 This finding is consistent with the result of studies conducted in Addis Ababa, Ethiopia (52.5%)  
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31 310 and Durban, South Africa (46%) (15, 16). However, this result is higher than that of a study done  
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33 311 in Gambia (19%) (13). The possible reason might be the difference in sociodemographic  
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35 312 characteristics, in which most participants in the Gambia study had less than five years of  
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37 313 experience and hadn't had a master's education level. On the other hand, the result of this study is  
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39 314 much lower than that of NICE, AORN, and ASPAN recommendation guidelines (3, 17, 21). This  
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41 315 discrepancy might be attributed to insufficient warming material, measurement material,  
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43 316 guidelines or protocol, and nurse training opportunities.

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45 317 Regarding nurses' knowledge of hypothermia prevention, this study identified that male nurses  
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47 318 had more knowledge than females. This might be explained by the fact that females have

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3 319 additional responsibilities at home, such as taking care of children, cooking, cleaning, and so on  
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5 320 (40). As a result, they might not have the time to read books or guidelines that broaden their  
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7  
8 321 knowledge in the field.

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10 322 This study also dictates that nurses who had BSC and master's degrees were more likely to have  
11  
12 323 good knowledge of hypothermia prevention compared to those who had a diploma. This finding  
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14 324 is supported by studies conducted in Iran (26) and Brazil (14). This implies that educational  
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17 325 interventions are fundamental for nurses to improve their scientific knowledge which in turn  
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19 326 increase the quality of patient care (14). Furthermore, this can be explained by the possibility that  
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21 327 nurses with higher educational status may be exposed to different courses related to preventing  
22  
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24 328 hypothermia.

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26  
27 329 Nurses' Knowledge and practice were higher among nurses who received training related to  
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29 330 hypothermia prevention compared to those who didn't. This finding is supported by other studies  
30  
31 331 in America (38), Brazil (41), Iran (26), and Turkey (4). This can be explained by the fact that  
32  
33 332 training plays an important role in improving the quality of patient care. This implies the need to  
34  
35 333 promote on-site and off-site training for nurses, which is an invaluable criterion, as training is  
36  
37  
38 334 necessary to update theoretical and practical knowledge in every aspect of nursing education  
39  
40 335 (40).

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42  
43 336 This study also showed that nurses working in recovery and intensive care units were more likely  
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45 337 to have good practice than those working in the emergency ward. This finding is inconsistent  
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48 338 with the study conducted in Turkey; ICU nurses had more knowledge than nurses working in  
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50 339 other wards, but their practice was not changing (4). The possible reason recovery and ICU  
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52 340 nurses had better practice might be that patients admitted to recovery and ICU wards need close  
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55 341 follow-up because of their physiological change or disturbance due to surgery or anesthesia. So,

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3 342 working in two wards, the nurses perform more activities, which maintain thermoregulation.  
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5 343 Another reason might be that the nurse-to-patient ratio is better than in other wards; the standard  
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8 344 is in recovery one to two, ICU one to one, emergency one to three, and for surgical and  
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10 345 orthopedic wards, it is one to six in Ethiopia. The other reason might be the better availability of  
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12 346 resources like a thermometer and warming materials. Also, most nurses in those two wards  
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14  
15 347 received more training than others.  
16

17 348 In this study, nurses who were satisfied with their jobs were 2.2 times more likely to have a good  
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19 349 level of practice than those who were not satisfied. Job satisfaction among nurses is highly  
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21 350 important in building employee interest and efficiency, as higher job satisfaction determines  
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23 351 better employee performance (42). Therefore, hospital administrators need to improve working  
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25 352 environments so that nurses feel comfortable, which will result in a positive attitude toward their  
26

27 353 jobs.  
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31 354 The other significant variable is that nurses who know about hypothermia prevention were 2.6  
32

33 355 times more likely to have good practices than those who do not. This study has supported by  
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35 356 studies conducted in Nigeria (43) and the Textbook of Brunner & Suddarth (44). AORN  
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37 357 guideline also supports, surgical team awareness, education, and understanding of hypothermia  
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39 358 are necessary to change how clinicians provide quality and effective patient care (35).  
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## 44 359 **Limitations of the study**

45  
46  
47 360 The study findings might be prone to social desirability bias, although this was minimized  
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49 361 through the use of self-administered questionnaires. In addition, the content validity of the  
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51 362 questionnaires was not formally assessed by independent experts. □ The study results  
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53 363 were not triangulated with findings from qualitative approaches, which could have enhanced our  
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3 364 findings. Finally, despite being a multicentre study covering a large area, the research findings  
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5 365 may not be generalized beyond the study setting.  
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## 8 366 **CONCLUSION**

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12 367 This study revealed that the knowledge and practice of nurses on the prevention of perioperative  
13  
14 368 hypothermia in the study area was inadequate compared to the recommended guidelines. Higher  
15  
16 369 educational status, being male, and attending training were significantly associated with good  
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18 370 knowledge of nurses on perioperative hypothermia prevention. Concurrently, nurse's working  
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20 371 wards, training opportunities, job satisfaction, and nurses' knowledge were the factors contributing  
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22 372 to good practice of nurses in preventing perioperative hypothermia.  
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26  
27 373 Therefore, hospital and healthcare managers need to design in-service training and long term  
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29 374 educational opportunities to improve nurses' knowledge and practice in the area. In addition,  
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31 375 hospitals need to fulfill the resources such as warming materials, thermometers, and updated  
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33 376 guidelines or protocols, and improve working environments so that nurses become safe and  
34  
35 377 comfortable resulting in a positive feeling towards their job. Furthermore, we recommended that  
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37 378 future researchers conduct a mixed methods study to provide sufficient evidence for  
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39 379 policymakers.  
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## 43 380 **List of abbreviation**

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47 381 AOR: Adjusted Odd Ratio; AORN: Association of perioperative Register Nurses; ASPAN:  
48  
49 382 American Society of PeriAnesthesia Nurses; CI: Confidence Interval; DMRH: Debre Markos  
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51 383 Referral Hospital; DTCRH: Debre Tabor Comprehensive Referral Hospital; EMS:Emergency  
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53 384 Medical Service; EPI INFO: Statistical Package for Epidemiological Information Analysis;  
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3 385 FHRH: Felege Hiwot Referral Hospital; ICU: Intensive Care Unit; IPH: Inadvertent  
4  
5 386 Perioperative Hypothermia; OR: Odds Ratio; OR: Operation Room; HP: Perioperative  
6  
7 387 Hypothermia; PI: Principal Investigator; RR: Recovery Room; SPSS: Statistical Package of  
8  
9 388 Social Science; T° c: Temperature In Degree Centigrade; TGSRH: Tibebe Gion Specialized  
10  
11 389 Referral Hospital; UK: United Kingdom; UoGCSRH: University of Gondar Comprehensive  
12  
13 390 Specialized Referral Hospital; USA: United States of America.  
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## 18 391 **Declarations**

### 21 392 **Ethical approval and consent to participate**

23 393 Ethical clearance was obtained from the University of Gondar Institutional Review Board (IRB)  
24  
25 394 with this Ref. No. S/R/164/2/2021. After explaining the purpose and possible benefits of the  
26  
27 395 study, a permission letter was obtained from each respective hospitals. Written informed consent  
28  
29 396 was obtained from each study participant before data collection. It was explained to the  
30  
31 397 respondents who participated in the study that voluntary and private information would be  
32  
33 398 protected. The process did not identify respondents by their names and respondent privacy was  
34  
35 399 maintained.  
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38

### 40 400 **Consent for publication**

42 401 Not applicable.  
43

### 44 402 **Data availability statement**

47 403 No additional data available.  
48

### 49 404 **Competing interests**

52 405 The authors declare that they have no competing interests.  
53

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3 407 None.  
4  
5

6 408 **Contributors**  
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8

9 409 AWW carried out the study, starting with designing the study, analyzing and interpreting the  
10  
11 410 data, and reviewing the manuscript. BYM, NT, and ED participated in developing the  
12  
13 411 measurement tool or questionnaire, proposal writing, data analysis, interpretation, and  
14  
15 412 commenting on drafts of the paper and manuscript. All authors involved in drafting, reviewing,  
16  
17 413 and editing of the manuscript. All authors read and approved the final manuscript before  
18  
19 414 submitting it to the journal for publication.  
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21

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32 419 contribution for the study.  
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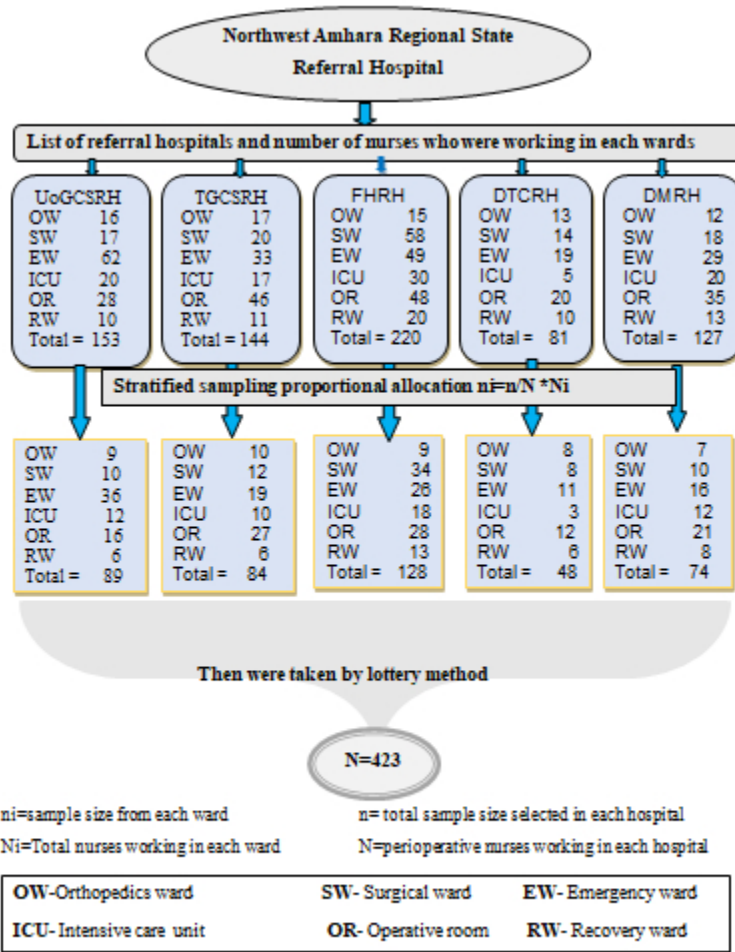
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Supplemental Table: Institutional and other related factors of the respondents on perioperative hypothermia prevention in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021 (N=413).

Variable	Response	Frequency (N=413)	Percentage (%)
Working place (hospital)	TGSRH	84	20.3
	UoGCSRH	83	20.1
	DMCRH	73	17.7
	DTCRH	47	11.4
	FHRH	126	30.5
Ward:	Emergency	103	24.9
	Recovery	39	9.4
	OR	102	24.7
	ICU	53	12.8
	Orthopedics ward	46	11.1
	Surgical ward	70	16.9
Daily working hours	≤ 8 hrs.	354	85.7
	≥9 hrs.	59	14.3
Training on hypothermia prevention	Yes	145	35.1
	No	268	64.9
Presence of protocol/guideline	Yes	121	29.3
	No	292	70.7
Reading updated evidence on hypothermia prevention	Yes	206	49.9
	No	207	50.1

Variable	Response	Frequency (N=413)	Percentage (%)
Availability of thermometer	Yes	145	35.1
	No	268	64.9
Constraints of warming material	Yes	342	82.8
	No	71	17.2
Shortage of blanket	Yes	166	40.2
	No	247	59.8
Shortage of linens	Yes	89	21.5
	No	324	78.5
Shortage of fluid warmer	Yes	132	32.0
	No	281	68.0
Shortage of air warmer/heater	Yes	212	51.3
	No	201	48.7
Shortage of warmer blanket	Yes	217	52.5
	No	196	47.5
Job satisfaction	Satisfied	217	52.5
	Dissatisfied	196	47.5



Supplemental Figure: Schematic presentation of sampling procedure of nurses' knowledge and practice, and associated factors on hypothermia prevention among surgical patients.

315x352mm (38 x 38 DPI)

## Annex I. Instruments (questionnaire)

Introduction: This instrument is divided into 3 sections. Section 1 is related to your Personal data including job satisfaction. Section 2 is your knowledge regarding Perioperative hypothermia prevention (PHP). Section 3 is your practice regarding PHP.

Identification number: \_\_\_\_\_

### I. Socio-demographic, institutional and other characteristics of study participants

1. Gender: Male  Female
2. Age: \_\_\_\_\_
3. Marital status A- Single B- Married C- Divorced D- Widowed
4. Educational level: A- Diploma B- Degree C- Masters
5. Working experience in days/months/years: \_\_\_\_\_
6. Working place (hospital) \_\_\_\_\_
7. Working unit or ward: \_\_\_\_\_
8. Daily working hours \_\_\_\_\_
9. Monthly salary \_\_\_\_\_
10. Did you receive any in service training on perioperative hypothermia prevention?  
Yes  No
11. Do you have guidelines related to hypothermia prevention in your workplace?  
Yes  No
12. Do you read journals on hypothermia prevention? Yes  No
13. Is there any shortage of thermometers? Yes  No
14. Is there any other resource constraints, which are important for the prevention of?  
Hypothermia prevention? Yes  No
15. If yes, what type of resource constraints? You can circle greater than one answer if appropriate



A. Blanket B. Linens C. Fluid warmer D. Air warmer/heater E. Blanket warmer

**16. Job satisfaction; Please tick one ( ) as per your choice**

<i>Job Satisfaction questions</i>		Strongly Agree 5	Agree 4	Neither 3	Disagree 2	Strongly disagree 1
1	I have a work plan developed with my supervisor					
2	My supervisor gives me feedback to improve my performance					
3	I get the opportunity to be involved in my performance appraisal					
4	my supervisor/head nurse does a good job					
5	I have the opportunity to work independently on my job					
6	I have good feeling towards my job accomplishment					
7	I have a chance for a variety of job responsibilities					
8	There is good flexibility for shift works					
9	I have good relationship with my coworkers					
10	I have good relationship with my supervisor and physicians.					
11	There is good team work spirit in my department					
12	There is good communication between from managers, to employees in the hospital					
13	I got sufficient support during my health problem					
14	There is good safety practice in the hospital					
15	I have a sense of job security					
16	I have the materials and equipment that need to do my work right.					
17	The mission of my organization makes me feel my job is important.					
18	I have got recognition for my good work					
19	There is a fair chance for promotion					
20	I have training that I need to do my job					
21	The hospital provides fair training opportunity					
22	There is high rate of turnover in the hospital					

23	High absenteeism is seen in some employee					
24	I feel stressed in my work					
25	I am satisfied with my Salary					
26	My salary is comparable to others who performing the same or similar jobs					
27	My benefits like transport, housing and duty allowance, etc., are fair compared to other staff at my level					

## II. Questions related to knowledge of hypothermia prevention in perioperative patients.

Please select and Put ( ) in the box below for each question.

Item no.	Statements about perioperative hypothermia prevention	True	False	I Don't Know
<b>Part 1</b>	<b>General knowledge</b>			
1	The internal environment of humans can be maintained by thermoregulation.			
2	Perioperative hypothermia at any time during the perioperative cycle is characterized as a core body temperature < 36 ° C			
3	Anesthetic drugs increase heat loss in surgical patients.			
4	Cold IV fluids and blood products increase heat loss.			
5	Perioperative hypothermia is not associated with complications such as changes in drug metabolism, healing complications, shivering, clotting defects, cardiac morbidity, and prolonged post-anesthetic recovery.			
6	To minimize surgical complications post-operatively, nurses should advise patients to bring along additional clothing to help them stay warm prior to surgery			
7	The pulmonary artery catheter, distal esophagus, urinary bladder, rectum, zero heat-flux are some of the sites for temperature measurements.			
8	Nurses should be well trained and knowledgeable about the use of both temperature recording and warming devices			
9	Forced-air warming devices, warm water circulating devices and conductive devices are not some of the devices for warming surgical patients			

10	The method for temperature monitoring should not be chosen based on the criteria for a procedure			
11	To ensure accurate information, the perioperative team takes the patient's temperature at 15- minute intervals using different measuring devices at different sites.			
<b>Part 2</b>	<b>Preoperative hypothermia prevention</b>			
1	Patients with a temperature below 36.0°C undergoing anesthesia & those having a high risk of cardiovascular complications are at higher risk for inadvertent perioperative hypothermia			
2	It is not necessary to measure patients' temperature in the hour before departing the ward since it will be measured at the theatre.			
3	Except in urgent circumstances, preoperative patients with temperatures of less than 36.0°C should be warmed for 30 minutes using active warming methods.			
4	Special attention should be given to the comfort of surgical patients having difficulties expressing themselves			
5	The method for warming surgical patients should be chosen based on the planned surgical procedure, positioning of the patient, Intravenous access site, and warming equipment constraints.			
<b>Part 3</b>	<b>Intraoperative hypothermia prevention</b>			
1	Critical incidence reporting is not necessary for patients coming into the theatre with a temperature of less than 36.0°C.			
2	Induction of anesthesia should not begin unless the patient's temperature is 36.0°C or above (unless there is a need to expedite surgery because of clinical urgency).			
3	The theatre's room temperature should be at least 21°C which can be adjusted to allow better working once active warming is initiated.			
4	All irrigation fluids used intraoperative should be warmed in a thermostatically controlled cabinet to a temperature of 38°C to 40°C.			
5	Fluid warming devices should be used to warm Intravenous fluids (500mls or more) & blood products to 37°C			
6	Regardless of the temperatures of patients before leaving the ward or emergency department, they should be warmed using active warming method once in the theatre			

7	The surgical patient should be well covered throughout surgery to conserve heat and only be exposed during surgical preparation.			
<b>Part 4</b>	<b>Post-operative hypothermia prevention</b>			
1	During the postoperative period, hypothermic patients should be warmed using active warming method until they become warm before transferring them to the ward.			
2	Patients should be provided with at least 1 cotton sheet, 2 blankets, or a duvet during the postoperative phase			
3	Whiles in the theatre, the patients' temperature should be measured every 15 minutes and every 30 minutes while in the recovery room.			
4	The temperature of post-operative patients should be recorded on arrival to the ward and be taken and documented as part of a routine four hourly observations.			

### III- Questions related to practice of hypothermia prevention in perioperative patients.

Please select and Put ( ) in the box below for each *question*.

Hypothermia prevention practices	Never/0	Sometimes/1	Always/2
1. Do you measure temperature as soon as patient arrival?			
2. Do you measure temperature regularly according to guidelines recommendation (for preoperative patient every 1hr, intraoperative every 30', recovery every 15' and post-operative every 4hrs)?			
3. Do you warm intravenous, blood products, and irrigation fluids using warming devices before administering to patients?			
4. Do you cover the mattress plastic sheet with dry linen before patient admission?			
5. Do you use forced-air warming devices, warm water circulating devices, and conductive devices for warming surgical patients?			
6. Do you communicate your assessment findings on factors that could lead to perioperative hypothermia to all members of the perioperative team?			

1 2 3 4	7. Do you advise patients to inform you when they feel cold during their hospitalization?			
5 6 7 8	8. Do you develop and implement the care plan for perioperative hypothermia prevention?			
9 10 11 12	9. Do you document the site for temperature measurement in the patients' file?			
13 14 15	10. Do you maintain ambient room temperature according to the guideline?			
16 17 18	11. Do you assess patients for their risk for perioperative hypothermia?			
19 20 21	12. Do you assess for signs and symptoms of hypothermia?			
22 23	13. Do you advise patients to stay warm prior to surgery?			
24 25 26 27 28	14. Do you include thermoregulation interventions and patient-related care to thermoregulation in your hand-over report			

**STROBE Statement—checklist of items that should be included in reports of observational studies**

	<b>Item No.</b>	<b>Recommendation</b>	<b>Page No.</b>	<b>Relevant text from manuscript</b>
<b>Title and abstract</b>	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	1	Line (1-3); An institution-based cross-sectional study was conducted for the title of Knowledge and Practice of nurses on Perioperative Hypothermia Prevention at Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia:
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2	Lines (21 – 47); Abstract
<b>Introduction</b>				
Background/ratio nale	2	Explain the scientific background and rationale for the investigation being reported	3 4, 5 and 6	Lines (56– 117); Introduction
Objectives	3	State-specific objectives, including any pre-specified hypotheses	6	Lines (115 – 117); This study aimed to assess nurses’ knowledge, practice, and their determinant factors of perioperative hypothermia prevention in Northwest Amhara Regional State Referral Hospitals, Northwest Ethiopia.
<b>Methods</b>				
Study design	4	Present key elements of study design early in the paper	6	Lines (120 – 121); An institutional-based cross-sectional study was conducted in five referral hospitals' perioperative units or

				wards from March 25 to May 20, 2021.
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6 and 7	Lines (122 – 138); Study setting
Participants	6	(a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up  Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls  Cross-sectional study—Give the eligibility criteria and the sources and methods of selection of participants	7 and 8	Lines (140 – 145); Source and study population  Lines (146– 150); Inclusion and exclusion criteria (eligibility criteria)  Lines (156 – 164); The study participants were recruited using a stratified sampling technique. Initially, the study participants are stratified by hospital and working ward or unit, and the required sample for each stratum is allocated proportionally.
		(b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed  Case-control study—For matched studies, give matching criteria and the number of controls per case	N/A	This was a cross-sectional study
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8 and 9	Lines (165 – 178); Variables and measurements
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	9	Lines (179 – 186); Data collection tools and procedures

Bias	9	Describe any efforts to address potential sources of bias	9 and 10	Lines (187–196); To assure the quality of the data, the questionnaire was prepared in English first, then translated to Amharic (local language), and then translated back to English to check its consistency. One-day training on the purpose of the study and the data collection procedure was provided to the data collectors and supervisors. Additionally, the tool was pretested at Woldia Comprehensive Referral Hospital with 5% of the sample size.
Study size	10	Explain how the study size was arrived at	8	Lines (152–155); The sample size was calculated using the single population proportion formula $(n = \frac{Z^2 * P * (1-P)}{d^2})$ . A 50% proportion of nurses' knowledge and practice on hypothermia prevention, 95% confidence level, and 5% expected margin of error (d) were used. By considering a 10% non-response rate, the final sample becomes 423.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10	Lines (204–210); Binary logistic regression was used to determine the significant association between the independent and dependent variables. Those independent variables, less than



				0.2 in bivariable analysis, were entered into multivariable logistic regressions. The association between the independent and dependent variables was considered significant if the P-value was less than 0.05 from multivariate logistic regression analysis. AOR with 95% CI and a p-value of < 0.05 were used to declare associated factors with the knowledge and practice of nurses on hypothermia prevention.
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	10	Lines (198–210); Statistical Analysis
		(b) Describe any methods used to examine subgroups and interactions	N/A	There were no subgroups
		(c) Explain how missing data were addressed	N/A	There was no missing data
		(d) Cohort study—If applicable, explain how loss to follow-up was addressed  Case-control study—If applicable, explain how matching of cases and controls was addressed  Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	8	Lines (156– 164); The study participants were recruited using a stratified sampling technique. Initially, the study participants are stratified by hospital and working ward or unit, and the required sample for each stratum is allocated proportionally. According to all hospitals' human resources and administration reports, the total number of nurses working in these units or wards was 725. The calculated sample size was then proportionally allocated to each hospital according to the number of nurses working in the respective departments or wards (i.e. from 153, 89 in UoGCSRH, from 144, 84 in TGRH, from 220, 128 in FHRH,

				from 81, 48 in DTRH, and from 127, 74 nurses in DMRH). Finally, study participants were chosen using a simple random sampling technique from each sampling frame
		(e) Describe any sensitivity analyses	N/A	
<b>Results</b>				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	N/A	This was a cross-sectional study with only one stage.
		(b) Give reasons for non-participation at each stage	N/A	
		(c) Consider use of a flow diagram	N/A	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, institutional, other) and information on exposures and potential confounders	11 and 12	Line (216-221); Table 1: Socio-demographic characteristics of the study participants on hypothermia prevention among perioperative patients in Amhara Regional State Referral Hospitals, Northwest Ethiopia, 2021(N=413).  Line (225-230); <b>Institutional and job-related factors of the respondents</b> of the study participants
		(b) Indicate number of participants with missing data for each variable of interest	N/A	There was no missing data
		(c) Cohort study—Summarise follow-up time (eg, average and total amount)	N/A	This was a cross-sectional study
Outcome data	15*	Cohort study—Report numbers of outcome events or	N/A	This was cross-sectional study

		summary measures over time		
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A	This was a cross-sectional study
		Cross-sectional study—Report numbers of outcome events or summary measures	12, 13, and 14	Lines (233–234); In this study, 244 (59.1%) with 95% CI: (54.7, 63.7) of the participants had good knowledge Lines (243–245); In this study, 208 (50.4%) with 95% CI: (45.5, 55) of the participants had good practice.
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12, 14, 16 and 18	Lines (233-234); In this study, 244 (59.1%) with 95% CI: (54.7, 63.7) of the participants had good knowledge Lines (243-245); In this study, 208 (50.4%) with 95% CI: (45.5, 55) of the participants had a good practice. Lines (260-261); Table 4- Bi-variable and multivariable analysis of factors associated with knowledge of nurses on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia. Lines (273-275); Table 5- Bi-variable and multivariable analysis of factors associated with the practice of nurses on perioperative hypothermia prevention in Amhara Region Referral Hospitals, Northwest Ethiopia.
		(b) Report category boundaries when continuous variables were categorized	N/A	There was no continuous variable.
		(c) If relevant, consider translating estimates of relative	N/A	There was no estimate of relative risk.

		risk into absolute risk for a meaningful time period		
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A	There was no sub groups and sensitivity analysis.
<b>Discussion</b>				
Key results	18	Summarise key results with reference to study objectives	20-23	Lines (277–354); Discussion
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	23 and 24	Lines (355–361); This study was not triangulated with a qualitative method. The study also might be prone to social desirability bias, which was minimized through the use of self-administered questionnaires. In addition, the content validity of the questionnaires was not formally assessed by independent experts. Despite the study being conducted in a multi-center setting or covering a large area, the research findings may not be generalized beyond the study setting, like at a national or global level, because no sample was collected outside our study settings.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	20-24	Lines (277-361); Discussion and limitation
Generalizability	21	Discuss the generalizability (external validity) of the study results	24	Lines (363-368); This study revealed that the knowledge and

				<p>practice of nurses on the prevention of perioperative hypothermia in the study area was inadequate compared to the recommended guidelines. Higher educational status, being male, and attending training were significantly associated with good knowledge of nurses on perioperative hypothermia prevention. Concurrently, nurse's working wards, training opportunities, job satisfaction, and nurses' knowledge were the factors contributing to good practice of nurses in preventing perioperative hypothermia.</p>
<b>Other information</b>				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	26	Lines (404)-This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.