Levels of knowledge regarding malaria causes, symptoms, and prevention measures among Malawian women of reproductive age

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Abstract
Background: Malawi is a malaria-endemic country and approximately 6 million cases are reported annually. Improving knowledge of malaria causes and symptoms, and the overall perception towards malaria and its preventive measures is vital for malaria control. Thus, the current study investigated the levels of knowledge of the causes, symptoms, and prevention of Malaria among Malawian women.
Methods: We analyzed data from the 2017 wave of the Malawi Malaria Indicator Survey (MIS). In total, 3,422 women of reproductive age (15–49 years) were sampled and analyzed. We assessed the levels of women’s knowledge about 1), causes of malaria 2) symptoms of malaria and 3) preventive measures. The tertiles of the composite score were used as the cut-offs to categorize the levels of knowledge as “low”, “medium” and “high”. Multinomial logistic regression models were constructed to assess the independent factors while taking into account the complex survey design.
Results: Approximately 50% of all respondents had high levels of knowledge of causes, symptoms, and preventive measures. The high level of knowledge was 45% for rural women and 55% for urban dwellers. After adjustment for known confounders, women of age group 15–19 years adjusted odds ratio ([aOR]: 2.576; 95% Confidence Interval [CI]: 1.692–3.921), women with no formal education (aOR: 3.733; 95% CI: 2.203–6.326), women whose household had no television (aOR: 1.504; 95% CI: 1.021–2.216), women who had not seen/heard malaria message (aOR: 1.527; 95% CI: 1.197–1.948), women of Yao tribe (aOR: 1.954; 95% CI: 1.103–3.460) and women from rural areas had low levels of knowledge about the causes of malaria, symptoms of malaria, and preventive measures.
Conclusions: The levels of malaria knowledge were reported to be moderate among adult women, underscoring the need to scale up efforts on malaria education. Beside insecticide-treated bed nets (ITNs) and prompt diagnosis, malaria can be best managed in Malawi by increasing knowledge of malaria causes, and symptoms especially for younger women, women with no formal education, women whose households have no media, women from Yao tribes and rural dwellers.

Background
Malaria, a life-threatening disease caused by plasmodium parasites, is a major public health issue in many tropical and subtropical areas especially in sub-Saharan Africa (SSA) countries [1][2]. The World
Health Organization (WHO) estimates that 228 million cases and 405,000 malaria-related deaths occurred in 2018 [2][3][4]. The SSA region bares an excessively high portion of the global malaria problem. Nonetheless, the WHO regions of South-East Asia, Eastern Mediterranean, Western Pacific, and the Americas are also becoming home for malaria. By the end of 2017, the sub-Saharan region was home to 92% of malaria cases and 93% of malaria deaths [2].

In Malawi, the Ministry of Health (MoH) through the national malaria control program (NMCP) focuses on scaling up the use of insecticide-treated bed nets (ITNs) by increasing their access and ownership [5]. The program also includes the provision of artemisinin-based combination therapies (ACTs) and intermittent preventive treatment for pregnant women (IPTp) using sulfadoxine-pyrimethamine (SP), as well as early diagnosis and prompt treatment [5]. However, despite all these interventions, Malawi remains a malaria-endemic country with an estimated 6 million cases reported annually [6]. This signifies that beyond strategies and interventions to fight against malaria, human behavior including knowledge also can play a vital role in reducing malaria transmission.

Knowledge related to health is of great essence for the reason that there is consistent evidence demonstrating the connection between individual healthy knowledge, health behavior, and health outcomes [7]. It has been reported that people with low levels of individual health knowledge are greater than 2 times more likely to experience poor health outcomes [8]. Unfortunately, there are inconsistent and conflicting reports regarding the levels of Malaria knowledge and associated factors [9][10][11][12]. Previous studies have reported that women who reside in urban areas, women with better family monthly income, women who attended formal education have better knowledge regarding causes, signs and symptoms and preventive measures of malaria [10]. WHO reported that having a good knowledge regarding malaria causes, signs and symptoms, mode of transmission and preventive measures lead to the use of the malaria prevention strategies and improve health-seeking behaviors [13].

Previous studies on malaria knowledge, attitudes, and practices (KAP) have reported the influence of malaria misconceptions on malaria control efforts [9][14]. Thus, evaluating malaria knowledge among women of reproductive age is of great essence since women are the ones largely involved in home-
based management of malaria especially to the highly vulnerable group (children below the age of 5 years) to malaria [15]. Furthermore, in settings where malaria transmission is high (such as Malawi), women of reproductive age are also a vulnerable group and susceptible to Malaria in the course of pregnancy [16][17]. Studies reported that malaria parasites may be present in the placenta contributing to placental malaria and maternal anemia which may result in adverse birth outcomes such as low birth weight [18].

Despite the benefits of malaria knowledge on malaria control efforts, little is known about the levels of knowledge on malaria causes, symptoms, and prevention among Malawian women [19][20]. Moreover, preponderance of previous studies that have examined factors linked to malaria-related knowledge have either examined the level of malaria knowledge in general (low versus high) or individual knowledge domains [21][22]. However, several factors may play different roles in influencing a specific type of malaria knowledge at different levels (i.e. low, medium and high) and therefore, evaluating them separately may provide a better understanding of the factors associated with the different levels of malaria knowledge. Thus, this study investigated the levels of malaria knowledge on the causes, symptoms, and prevention among Malawian women.

Methods
Study design
This was a cross-sectional study that used data from the 2017 Malawi Malaria Indicator Survey (2017 MMIS) [23]. The 2017 MMIS was conducted with respect to Roll Back Malaria Monitoring and Evaluation Working Group (RBM-MERG) guidelines. [23].

Sampling Technique
The survey used a two-stage sampling design and it permits the estimates of key malaria indicators for the country as a whole, as well as separately for urban and rural areas in all the 3 administrative regions in Malawi. In brief, the first stage involved selecting clusters from the enumeration areas (EAs). A total of 150 clusters were selected (60 clusters in urban areas and 90 clusters in rural areas), with probability proportional to size, from the EAs covered in the 2008 Population and Housing Census (PHC). The second stage systematically selected households from a list that was undertaken in all selected EAs and households were randomly selected from these lists. Thus, 25 households were
selected for a total sample size of 3,750 households.

Data collection
The primary objective of the 2017 MMIS was to collect information on mosquito nets, IPTp, and care-seeking behavior and treatment of fever in children. All women between 15 and 49 years of age who were either permanent residents of the selected households or visitors who stayed in the household the night before the survey were interviewed. Through face to face interviews knowledge related to malaria was collected from the women of reproductive age. Data was primarily collected using three types of questionnaires: the Household Questionnaire, the Woman’s Questionnaire, and the Biomarker Questionnaire. This study focused on responses from the women’s questionnaire which collected malaria information (such as malaria KAP) from women aged 15–49 years.

Study Variables
Dependent variable
Overall, the knowledge score related to malaria was assessed by aggregating the three domains of knowledge related variables namely (i) causes, (ii) symptoms, and (iii) preventive measures. The Malawi MIS 2018 included a number of basic questions that were used to explore malaria-related knowledge among adult women. These domains are described in detail as follows: Knowledge about causes: Question was asked, what do you think is the cause of malaria? The following were answers; 1) Mosquito bites, (2) eating immature sugarcane, (3) eating cold nsima, (4) insufficient sleeping, (5) eating dirty food, (6) drinking dirty water, (7) getting soaked in rain, (8) cold or changing weather, and (9) witchcraft. Knowledge about common symptoms of malaria: The question was also asked; what signs or symptoms would lead you to think that a person has malaria? The answers to this question were; (1) fever, (2) feeling cold, (3) headache, (4) vomiting, (5) diarrhea, (6) dizziness, (7) loss of appetite, (8) body ache or joint pain, (9) pale eyes, (10) salty-tasting palms, (11) feeling weak, and (12) refuse to eat or drink. Knowledge about preventive/protective measures: Lastly, the question was asked; how can someone protect themselves against malaria? The following answers were provided to the question; (1) sleep under a treated net, (2) sleeping under an insecticide-treated mosquito net, (3) using mosquito net, (4) taking preventive medication, (5) spraying the house/rooms with insecticide, (6) clear weeds around the house, (7) using mosquito coils, (8) cutting grass around
(9) filling in stagnant waters (puddles), (10) keeping the surroundings clean, (11) burning leaves, (12) avoiding drinking dirty water, (13) avoiding eating bad food, (14) putting screens on windows, and (15) avoid getting soaked in rain. Comprehensive questions asked to calculate malaria knowledge score can be accessed from the MIS report [23]. All the knowledge related variables were recoded to binary level such that the correct answer was coded 1 while an incorrect answer was coded 0. Using an array command in SAS, knowledge score was calculated by summing up all the knowledge variables, with 0 recorded as the least possible score and 36 recorded as the highest possible score. Increasing score indicated better malaria knowledge. Finally, the tertiles of the composite score was used as the cut-off to categorize the levels of knowledge as “low”, “medium” and “high”. Women who scored 33% and below of knowledge score were categorized as having low knowledge, those who scored between 33% and 66% of the knowledge score were classified as having medium knowledge, and women who scored within the exact the 67% cut off and above were classified as having high knowledge.

**Independent Variables**

Based on an insights from the relevant literature [21][22], the following covariates were treated appropriate for our analysis. Women’s age in years (15–19, 20–24, 25–29, 30–34, 35–39, and 45–49), educational attainment (no formal education, primary, and secondary and higher education), Household has radio (no, yes), household has television (no, yes), sex of household head (male, female), wealth index (poorest/poorer/middle, richer, richest), seen/heard malaria message (no, yes), ethnicity (Chewa, Tumbuka, Lomwe, Yao, Ngoni, Other), place of residence (urban, rural), and geographical region (northern, central, southern). The wealth index is a composite measure of a household’s cumulative living standard. The household wealth index is derived using easy-to-collect data on a household's ownership of selected assets, such as televisions and bicycles; materials used for housing construction; and types of water access and sanitation facilities [24]. Using a statistical procedure known as principal component analysis (PCA), the wealth index assigned individual households on a continuous scale of relative wealth.

**Statistical Analyses**
Firstly, descriptive analyses were conducted where by the baseline characteristics of the study sample were presented as weighted frequencies and percentages. Secondly, the bivariate analyses were performed using chi-square (Rao-Scott Chi-Square Test) to determine the distribution of sociodemographic characteristics according to the levels (low, medium, and high) of knowledge related to prevention, symptoms, and causes of malaria. The variables that indicated significance at p-value equal or less than 0.25 on Chi-Square were retained for regression analysis models in order to allow the inclusion of more relevant descriptive variables. Thirdly, the multivariate analyses were performed by means of multinomial logistic models since the outcome variable was a three-way category of low, medium, and high levels of knowledge related to prevention, symptoms, and causes of malaria. Furthermore, we conducted multiple linear regression to investigate the knowledge score related to malaria among adult women as a continuous variable. Due to complex design of the sampling technique (multi-stage cluster), the survey-specific SAS procedures for weighting, clustering, and stratification in the survey design were conducted. In each model, adjusted odds ratios (aORs) and 95% confidence intervals (CIs) with their p-values were calculated. The results of the multiple linear regression were expressed as standardized betas and standard errors. Variance Inflation Factor (VIF) and Tolerance were conducted to examine the presence of multicollinearity among the independent factors at the cut offs of 10 and greater than 0.1. Significance was defined as p-value < 0.05. All data analyses were conducted using SAS for Windows, version 9.4 (SAS Institute, Cary, NC, USA).

Ethical Consideration
The 2017 MMIS data is available for public use upon request from the Measure Demographic and Health Survey (Measure DHS Program). The 2017 MMIS the survey was implemented by the by the Malawi National Malaria Control Programme (NMCP) while the ICF offered technical assistance through The DHS Program. The 2017 MMIS received ethical clearance from the Malawi National Health Sciences Research Committee (NHSRC) and the Institutional Review Board (IRB) of ICF Macro. An IRB of ICF Macro ensured that the 2017 MMIS was conducted in line with the U.S. Department of Health and Human Services regulations for the protection of human subjects – the Code of Federal
Regulations Title 45: Public Welfare, part 46 (45 CFR 46) [25], while the NHSRC certified that the survey was executed in line with Malawian laws and norms. Furthermore, before the interviews, verbal informed assent was obtained from the heads of the household to participate in the household questionnaire, and each eligible woman to participate in the women’s questionnaire. Participants were assured that participation in 2017 MMIS was voluntary and that no punishment would be given if they choose not to participate or stop answering questions.

Results
Baseline characteristics of the study participants by place of residence
Table 1 shows the descriptive characteristics of the study participants stratified by place residence. In total 3422 women of reproductive age: 15–49 years (1602 women from urban and 1820 women from rural areas) were analyzed in this study. Overall, approximately 50% of adult women were estimated to have the high levels of knowledge related to the causes, signs and symptoms and preventive measures of malaria. More than half of the women had primary school education (54%). However, a majority of women had no radio (53%), television (72%), and had not seen/heard malaria message (64%). A majority of participants were living in a male headed households (73%) and a majority of women southern region (54%) dwellers. The differences between women from urban and rural areas were statistically significant with respect to the women’s age ($P = 0.0003$), maternal education levels ($P < .0001$), and household having a radio ($P < .0001$), household having a television ($P < .0001$), sex of household head ($P = 0.0367$), household wealth ($P.0001$), ethnicity ($P = 0.0003$), and access to malaria messages ($P < .0001$).
Table 1
Characteristics of study respondents according to place of residence n = 3422. MMIS 2017

| Age of the respondents | Total Sample | Urban | Rural | P-value |
|------------------------|--------------|-------|-------|---------|
| 15–19                  | 703 (20.54)  | 315 (44.81) | 388 (59.19) | 0.0003  |
| 20–24                  | 694 (20.28)  | 340 (48.99) | 354 (51.01) |
| 25–29                  | 590 (17.24)  | 284 (46.14) | 306 (51.86) |
| 30–34                  | 575 (16.80)  | 293 (50.96) | 282 (49.04) |
| 35–39                  | 436 (12.74)  | 212 (48.62) | 224 (51.38) |
| 40–49                  | 424 (12.39)  | 158 (37.26) | 266 (62.74) |

| Highest educational level | Total Sample | Urban | Rural | P-value |
|---------------------------|--------------|-------|-------|---------|
| No formal education      | 252 (7.36)   | 52 (20.63) | 200 (79.37) | < .0001 |
| Primary                  | 1847 (53.97) | 609 (32.97) | 1238 (67.03) |
| Secondary and above      | 1323 (38.66) | 941 (71.13) | 382 (28.87) |

| Household has radio | Total Sample | Urban | Rural | P-value |
|---------------------|--------------|-------|-------|---------|
| No                  | 1805 (52.75) | 564 (31.25) | 1241 (68.75) | < .0001 |
| Yes                 | 1617 (47.25) | 1038 (64.19) | 579 (35.81) |

| Household has television | Total Sample | Urban | Rural | P-value |
|--------------------------|--------------|-------|-------|---------|
| No                       | 2442 (71.36) | 768 (31.45) | 1674 (68.55) | < .0001 |
| Yes                      | 980 (28.64)  | 834 (85.10) | 146 (14.90) |

| Sex of household head | Total Sample | Urban | Rural | P-value |
|-----------------------|--------------|-------|-------|---------|
| Male                  | 2514 (73.47) | 1150 (45.74) | 1364 (54.26) | 0.0367 |
| Female                | 908 (26.53)  | 452 (49.78) | 456 (50.22) |

| Wealth index | Total Sample | Urban | Rural | P-value |
|--------------|--------------|-------|-------|---------|
| Poorest/ Poorer/ Middle | 1169 (34.16) | 42 (3.59) | 1127 (96.41) | < .0001 |
| Richer       | 627 (18.32)  | 187 (29.82) | 440 (70.18) |
| Richest      | 1626 (47.52) | 1373 (84.44) | 253 (15.56) |

| Seen/heard malaria message | Total Sample | Urban | Rural | P-value |
|-----------------------------|--------------|-------|-------|---------|
| No                          | 2200 (64.29) | 979 (44.50) | 1221 (55.50) | 0.0003 |
| Yes                         | 1222 (35.71) | 623 (50.98) | 599 (49.02) |

| Ethnicity | Total Sample | Urban | Rural | P-value |
|-----------|--------------|-------|-------|---------|
| Chewa     | 977 (28.55)  | 426 (43.60) | 551 (56.40) | < .0001 |
| Tumbuka   | 751 (21.95)  | 347 (46.21) | 404 (53.79) |
| Lomwe     | 462 (13.50)  | 218 (47.19) | 244 (52.81) |
| Yao       | 358 (10.46)  | 152 (42.46) | 206 (57.54) |
| Ngoni     | 392 (11.46)  | 227 (57.91) | 165 (42.09) |
| Other     | 482 (14.09)  | 232 (48.13) | 250 (51.87) |

| Region | Total Sample | Urban | Rural | P-value |
|--------|--------------|-------|-------|---------|
| Northern | 1176 (34.37) | 544 (46.26) | 632 (53.74) | 0.5540 |
| Central  | 1160 (33.90) | 558 (48.10) | 602 (51.90) |
| Southern | 1086 (33.90) | 500 (46.04) | 582 (53.96) |

| Knowledge* | Total Sample | Urban | Rural | P-value |
|------------|--------------|-------|-------|---------|
| Low        | 972 (28.40)  | 335 (34.47) | 637 (65.53) | < .0001 |
| Medium     | 748 (21.86)  | 337 (45.05) | 411 (54.94) |
| High       | 1702 (49.74) | 930 (54.64) | 772 (45.36) |

*Categorized based on the variable tertiles; † Tonga, Nkhonde, Sena, and Other

Characteristics of the study participants by levels of knowledge

Table 2 displays the prevalence of the levels of knowledge related to the causes, signs and symptoms, and preventive measures of malaria among women of reproductive age by selected characteristics. The levels of knowledge related to the causes, signs and symptoms, and preventive measures of malaria was significantly high among women of age group 40–49 years (P < .0001), among women with secondary and higher education (P < .0001), and among women who has a radio (P < .0001) as well as those who had television in their households (P < .0001). Furthermore, the high
levels of knowledge related to the causes, signs and symptoms, and preventive measures of malaria was observed among women from richest households (P < .0001), among women who seen/heard about malaria message (P < .0001), among Tumbuka women (P < .0001), among urban (P < .0001) and northern dwellers (P = 0.0001).

Table 2

| Covariates                        | Low     | Medium  | High    | P-value |
|-----------------------------------|---------|---------|---------|---------|
| Age of the respondents            |         |         |         |         |
| 15–19                             | 242 (34.42) | 160 (22.76) | 301 (42.82) | 0.0002  |
| 20–24                             | 205 (29.54) | 154 (22.19) | 335 (48.27) |         |
| 25–29                             | 152 (25.76) | 142 (20.40) | 296 (50.17) |         |
| 30–34                             | 151 (26.26) | 128 (22.16) | 296 (51.48) |         |
| 35–39                             | 106 (24.31) | 94 (21.56)  | 236 (54.13) |         |
| 40–49                             | 116 (27.36) | 70 (16.51)  | 238 (56.13) |         |
| Highest educational level         |         |         |         | < .0001 |
| No formal education               | 144 (45.24) | 56 (22.22)  | 82 (32.54)  |         |
| Primary                           | 613 (33.19) | 419 (22.69) | 815 (44.13) |         |
| Secondary and above               | 245 (18.52) | 273 (20.63) | 805 (60.85) |         |
| Household has radio               |         |         |         | < .0001 |
| No                                | 620 (34.35) | 408 (22.60) | 777 (43.05) |         |
| Yes                               | 352 (21.77) | 340 (21.03) | 925 (57.20) |         |
| Household has television          |         |         |         | < .0001 |
| No                                | 807 (33.05) | 548 (22.44) | 1087 (44.51) |       |
| Yes                               | 165 (16.84) | 200 (20.41) | 615 (62.76) |         |
| Sex of household head             |         |         |         | 0.9604  |
| Male                              | 717 (28.52) | 550 (21.88) | 1247 (49.60) |       |
| Female                            | 255 (28.08) | 198 (21.81) | 455 (50.11) |         |
| Wealth index                      |         |         |         | < .0001 |
| Poorest/ Poorer/ Middle           | 463 (39.61) | 275 (23.52) | 431 (36.87) |         |
| Richer                            | 183 (29.19) | 136 (21.69) | 308 (49.12) |         |
| Richest                           | 326 (20.05) | 337 (20.73) | 963 (59.23) |         |
| Seen/heard malaria message        |         |         |         | < .0001 |
| No                                | 717 (32.59) | 497 (22.59) | 986 (44.82) |         |
| Yes                               | 255 (20.87) | 251 (20.54) | 716 (58.59) |         |
| Ethnicity                         |         |         |         | < .0001 |
| Chewa                             | 327 (33.47) | 219 (22.42) | 431 (44.11) |         |
| Tumbuka                           | 189 (25.17) | 138 (18.38) | 424 (56.46) |         |
| Lomwe                             | 116 (25.11) | 115 (24.89) | 231 (50.00) |         |
| Yao                               | 133 (37.15) | 84 (23.46)  | 141 (39.39) |         |
| Ngoni                             | 89 (22.70)  | 94 (23.98)  | 209 (53.32) |         |
| Other                             | 118 (24.48) | 98 (20.33)  | 266 (55.19) |         |
| Place of residence                |         |         |         | < .0001 |
| Urban                             | 335 (20.91) | 337 (21.04) | 930 (58.05) |         |
| Rural                             | 637 (35.00) | 411 (22.58) | 772 (42.42) |         |
| Region                            |         |         |         | 0.0001  |
| Northern                          | 294 (25.00) | 233 (19.81) | 649 (55.19) |         |
| Central                           | 358 (30.86) | 253 (21.81) | 549 (47.33) |         |
| Southern                          | 320 (29.47) | 262 (24.13) | 504 (46.41) |         |

*Categorized based on the variable tertiles, ‡Tonga, Nkhonde, Sena, and Other

Characteristics of the study participants by educational level

Table 3 shows the characteristics of study respondents by highest educational level among women.

Women who had secondary and higher education were more likely to own a radio in the households (P < .0001) and television in their households (P < .0001). Furthermore, women who had secondary
and higher education resided in richest households (P < .0001), had seen or heard malaria message (P < .0001), were from Tumbuka ethnic group (P < .0001), were urban (P < .0001) and northern region (P < .0001) dwellers.

Table 3
Characteristics of study respondents by highest educational level among women. MMIS 2017

| Covariates                  | No education | Primary education | Secondary and above education | p-value |
|-----------------------------|--------------|-------------------|-------------------------------|---------|
| Household has radio         |              |                   |                               |         |
| No                          | 182 (72.22)  | 1145 (61.99)      | 478 (36.13)                   | < .0001 |
| Yes                         | 70 (27.78)   | 702 (38.01)       | 845 (63.87)                   |         |
| Household has television    |              |                   |                               | < .0001 |
| No                          | 240 (95.24)  | 1573 (85.17)      | 629 (47.54)                   |         |
| Yes                         | 12 (4.76)    | 274 (14.83)       | 694 (52.46)                   |         |
| Wealth index†              |              |                   |                               | < .0001 |
| Poorest/Poorer/Middle       | 167 (66.27)  | 866 (46.89)       | 136 (10.28)                   |         |
| Richer                      | 52 (20.63)   | 403 (21.82)       | 172 (13.00)                   |         |
| Richest                     | 33 (13.10)   | 578 (31.29)       | 1015 (76.72)                  |         |
| Seen/heard malaria message |              |                   |                               | < .0001 |
| No                          | 207 (82.14)  | 1293 (70.01)      | 700 (52.91)                   |         |
| Yes                         | 45 (17.86)   | 554 (29.99)       | 623 (47.09)                   |         |
| Ethnicity                   |              |                   |                               | < .0001 |
| Chewa                       | 104 (41.27)  | 538 (29.13)       | 335 (25.32)                   |         |
| Tumbuka                     | 14 (5.56)    | 363 (19.65)       | 374 (28.27)                   |         |
| Lomwe                       | 28 (11.11)   | 270 (14.62)       | 164 (12.40)                   |         |
| Yao                         | 43 (17.06)   | 224 (12.13)       | 91 (6.88)                     |         |
| Ngoni                       | 25 (9.92)    | 194 (10.50)       | 173 (13.08)                   |         |
| Other‡                      | 38 (15.08)   | 258 (13.97)       | 186 (14.06)                   |         |
| Place of residence          |              |                   |                               | < .0001 |
| Urban                       | 52 (20.63)   | 609 (32.97)       | 941 (71.13)                   |         |
| Rural                       | 200 (79.37)  | 1248 (67.03)      | 382 (28.87)                   |         |
| Geographical region         |              |                   |                               | < .0001 |
| Northern                    | 37 (14.68)   | 590 (31.94)       | 549 (41.50)                   |         |
| Central                     | 109 (43.25)  | 648 (35.09)       | 403 (30.46)                   |         |
| Southern                    | 106 (42.06)  | 609 (32.97)       | 371 (28.04)                   |         |

†Tonga, Nkhonde, Sena, and other; †a composite measure of a household’s cumulative living standard. It is calculated by using easy-to-collect data on a household’s ownership of selected assets, such as televisions and bicycles; materials used for housing construction and types of water access and sanitation facilities.

Factors associated with the levels of knowledge related to the causes, signs and symptoms, and preventive measures of malaria - low versus high knowledge

Table 4 presents the factors associated with the levels of knowledge related to the causes, signs and symptoms, and preventive measures of malaria among adult women. Compared to women aged between 40–49 years, younger women (15–19 years) had high odds of having low knowledge (adjusted odds ratio [aOR]: 2.576; 95% confidence interval [CI]: 1.692–3.921). Moreover, the odds were also significantly high among women who had no formal education (aOR: 3.733; 95% CI: 2.203–6.326) compared to women who had secondary and higher education. Furthermore, the odds of having low levels of knowledge related to the causes, signs and symptoms, and preventive measures
of malaria was high in women who had no television in their households (aOR: 1.504; 95% CI: 1.021-2.216) as well as women who had not seen or heard malaria messages (aOR: 1.527; 95% CI: 1.197-1.948) compared to women who television in their households and had seen or heard malaria message respectively. Additionally, compare to women from other ethnic groups, Yao women were had high odds of having low knowledge (aOR: 1.954; 95% CI: 1.103-3.460) related to the causes, signs and symptoms, and preventive measures of malaria. Conversely, the women from urban areas were 43% (aOR: 0.573; 95% CI: 0.355-0.924) less likely to have low knowledge. Table 3 also shows the effect of selected factors associated with the knowledge score of the causes, symptoms and preventive measures of malaria. The results showed that women aged 15–19 years (beta [β] = -0.7302, standard error [SE] = 0.1211), women with no formal education (β = -1.1734, SE = 0.1532), and women who had not seen or heard malaria message (β = -0.4107, SE = 0.0718) were negatively associated with high knowledge score.

### Table 4
Multinomial adjusted odds ratios and multiple linear regression of malaria related knowledge* among the adult women in Malawi.

| Covariates               | Low vs high knowledge | p-value | Medium vs high knowledge | p-value | Knowledge score | p-value |
|--------------------------|-----------------------|---------|--------------------------|---------|-----------------|---------|
|                          | AOR 95% (CI)          |         | AOR 95% (CI)             |         | β (SE)          |         |
| Maternal age             |                       |         |                          |         |                 |         |
| 15–19                    | 2.576 (1.692–3.921)   | <.0001  | 2.032 (1.365–3.025)      | 0.0006  | -0.7302 (0.1211)| <.0001 |
| 20–24                    | 1.840 (1.190–2.844)   | 0.0064  | 1.784 (1.146–2.776)      | 0.0107  | -0.6079 (0.1219)| <.0001 |
| 25–29                    | 1.454 (0.957–2.208)   | 0.0791  | 1.921 (1.300–2.838)      | 0.0012  | -0.3919 (0.1247)| 0.0017 |
| 30–34                    | 1.290 (0.818–2.034)   | 0.2713  | 1.476 (0.952–2.290)      | 0.0816  | -0.2696 (0.1242)| 0.0300 |
| 35–39                    | 1.170 (0.785–1.742)   | 0.4382  | 1.394 (0.834–2.382)      | 0.2031  | -0.2357 (0.1313)| 0.0728 |
| 40–49                    | 1.00                  | 1.00    | 1.00                     | 1.00    |                 |         |
| Highest educational level|                       |         |                          |         |                 |         |
| No education             | 3.733 (2.203–6.326)   | <.0001  | 1.978 (1.246–3.139)      | 0.0041  | -1.1734 (0.1532)| <.0001 |
| Primary                  | 2.023 (1.513–2.703)   | <.0001  | 1.389 (1.038–1.860)      | 0.0274  | -0.6483 (0.0821)| <.0001 |
| Secondary and above      | 1.00                  | 1.00    | 1.00                     | 1.00    |                 |         |
| Household has radio |        |        |        |        |        |
|---------------------|--------|--------|--------|--------|--------|
| No                  | 1.141  | 0.3845 | 0.988  | -0.1472| 0.0715 |
|                     | (0.846-1.540) |        | (0.762-1.282) |        |        |
| Yes                 | 1.00   | 1.00   | 1.00   | 1.00   | 1.00   |

| Household has television |        |        |        |        |        |
|--------------------------|--------|--------|--------|--------|--------|
| No                       | 1.504  | 0.0393 | 1.079  | -0.1171| 0.2578 |
|                         | (1.021-2.216) |        | (0.746-1.562) |        |        |
| Yes                      | 1.00   | 1.00   | 1.00   | 1.00   | 1.00   |

| Wealth index†           |        |        |        |        |        |
|-------------------------|--------|--------|--------|--------|--------|
| Poorest/Poorer/Middle   | 1.196  | 0.5078 | 1.101  | -0.1423| 0.2995 |
|                         | (0.702-2.036) |        | (0.682-1.778) |        |        |
| Richer                  | 0.869  | 0.5266 | 0.916  | -0.0221| 0.8562 |
|                         | (0.561-1.346) |        | (0.584-1.438) |        |        |
| Richest                 | 1.00   | 1.00   | 1.00   | 1.00   | 1.00   |

| Seen/heard malaria message |        |        |        |        |        |
|-----------------------------|--------|--------|--------|--------|--------|
| No                          | 1.527  | 0.0008 | 1.231  | -0.4107<.0001 |
|                            | (1.197-1.948) |        | (0.916-1.655) |        |        |
| Yes                         | 1.00   | 1.00   | 1.00   | 1.00   | 1.00   |

| Ethnicity                  |        |        |        |        |        |
|----------------------------|--------|--------|--------|--------|--------|
| Chewa                      | 1.508  | 0.1212 | 1.143  | 0.5953 | 0.4465 |
|                            | (0.896-2.537) |        | (0.697-1.874) |        |        |
| Tumbuk a                   | 0.844  | 0.4876 | 0.943  | 0.8266 | 0.7381 |
|                            | (0.521-1.367) |        | (0.558-1.595) |        |        |
| Lomwe                      | 0.943  | 0.9619 | 1.188  | 0.4505 | 0.8256 |
|                            | (0.558-1.595) |        | (0.757-1.864) |        |        |
| Yao                        | 1.954  | 0.0219 | 1.299  | 0.2695 | 0.9700 |
|                            | (1.103-3.460) |        | (0.815-2.069) |        |        |
| Ngoni                      | 0.852  | 0.5937 | 0.989  | 0.9604 | 0.7407 |
|                            | (0.471-1.542) |        | (0.626-1.562) |        |        |
| Other‡                     | 1.00   | 1.00   | 1.00   | 1.00   | 1.00   |

| Place of residence          |        |        |        |        |        |
|-----------------------------|--------|--------|--------|--------|--------|
| Urban                       | 0.573  | 0.0228 | 0.641  | 0.0205 | 0.1780 |
|                            | (0.355-0.924) |        | (0.411-0.933) |        |        |
| Rural                       | 1.00   | 1.00   | 1.00   | 1.00   | 1.00   |

| Geographical region         |        |        |        |        |        |
|-----------------------------|--------|--------|--------|--------|--------|
| Northern                    | 0.765  | 0.2175 | 0.627  | 0.0438 | 0.1297 |
|                            | (0.498-1.173) |        | (0.398-0.987) |        |        |
| Central                     | 0.868  | 0.5173 | 0.799  | 0.2365 | 0.8091 |
|                            | (0.564-1.336) |        | (0.551-1.160) |        |        |
| Southern                    | 1.00   | 1.00   | 1.00   | 1.00   | 1.00   |

*Categorized based on the variable tertiles; ‡Tonga, Nkhonde, Sena, and other; †a composite measure of a household’s cumulative living standard. It is calculated by using easy-to-collect data on a household’s ownership of selected assets, such as televisions and bicycles; materials used for housing construction and types of water access and sanitation facilities; ¶calculated as the sum of the 36 knowledge related variables, with 0 as the least possible score and 36 as highest possible score; β, beta; SE, Standard Error.

**Discussion**

This is the first study to report the factors associated with knowledge score also the levels of knowledge of the causes, symptoms, and prevention of malaria women of reproductive age in Malawi
using a nationally representative sample in Malawi. Malaria knowledge, attitudes, and practices (KAP) have reported the influence of malaria misconceptions on malaria control efforts [9][14]. Often times, women play a vital role for their families in bringing about awareness regarding malaria prevention and control [26]. Thus, an effort to study the knowledge on causes, symptoms and preventive measures of malaria among women of reproductive was vital in appreciating the degree and influence of malaria programmatic efforts in malaria control in Malawi. Overall, the levels of knowledge in this study was reported to be moderate among adult women, which implies that the knowledge related to malaria should be scaled-up.

Elsewhere lower levels of individual health knowledge have been reported to be linked with (i) increased rates of hospitalization and higher use of emergency care, (ii) poorer ability to demonstrate taking medications appropriately and poorer ability to interpret labels and health messages, (iii) lower use of mammography and lower uptake of the influenza vaccine, (iv) poorer knowledge among patients of their own disease or condition and many more [8][27][28]. After adjustment for possible confounders, lower levels of knowledge about the causes, symptoms, and preventive measures of malaria was found to be high in women of age group 15–19 years, women with no formal education, women whose household had no television, women who had not seen or heard malaria message, women of Yao tribe and women from rural areas. Whilst, women of age group 15–19 years, women with no formal education, and women who had not seen or heard malaria message were negatively associated with an increased in malaria knowledge score.

In this study, younger women (15 to 19 years) were negatively associated with the knowledge score as well as more likely to have lower levels of knowledge about the causes, symptoms, and preventive measures of malaria. The reasons behind this finding cannot be expressed explicitly. However, lack of experience among young mothers regarding childcare practices might contribute to the lower levels of knowledge related to malaria. Other studies have reported that being inexperienced as a caregiver was one of the major risk factors of not poor childcare practices and health outcomes [29]. It can be hypothesized older women might have had prior malaria episodes, hence a high probability to have better knowledge about the causes, symptoms and prevention measures. Additionally, it is believed
that older women might have had quite a lot of exposures to malaria messages compared to younger counterparts [30].

Although insignificant, our finding indicated that women from the poorest households were negatively associated with knowledge score as well as had low levels of malaria related knowledge. This association may be due to the fact that women from the poorest households may find it hard to access information regarding malaria, and may not access goods and services that otherwise would protect them against the mosquitoes that transmit of malaria [31]. Furthermore, geographic location may hinder women from the poorest household may find it hard to reach to the health facilities while they are not feeling well. This is evidenced by our results presented in Table 1 where a majority of poorest women were from rural areas. Thus, women are more likely to miss out information related to malaria due to problem with the distance to the nearest health facility as well poor road networks to reach to the health facility. Previous studies also suggested that women from the poor households may have barriers to access health services including access to health information compared to mothers from rich households [32].

The current study revealed that educational status was also important variable which was significantly associated with knowledge on malaria among women of reproductive age. The finding of this study is in line with the studies that were conducted in Ghana [30], Nigeria [11], Burkina Faso and [22]. An explanation to this association may be due to the fact that educated mothers may not have problems to read and comprehend information concerning malaria. Another reason might be that, highly educated women may reside in richest households and urban areas where distance to health facilities may not be a big problem [33]. Further, educated women may have better knowledge about their own health as well as better health-seeking behavior [34]. In this study we have demonstrated that women who had seen or heard about malaria messages had better knowledge score and that women who had secondary and higher education were more likely to have seen or heard malaria message Table 3.

The findings of this study also revealed that living in the urban areas increased the level of knowledge on malaria among women. An explanation may be that women who are from urban areas may be
more exposed for messages or information like mass media and other health-related messages than women from rural areas such as Television, radio, newspapers, posters or billboards, peer educators etc. Our results in Table 3 are supporting this theory where women who had access to radio, television, and had seen or heard malaria messages were more likely to be urban dwellers. This finding was also reported in prior studies done in Nigeria [18], Ethiopia [34], and Tanzania [19]. Finally, the finding of this study reported that Yao women were more likely to have lower knowledge of malaria. Usually, the differences in ethnicity reflect variations with respect to sociodemographic, economic, and environment among ethnic groups. In Malawi, Yao tribe is known to have few people with formal education due to their cultural values. The results in Table 3 demonstrated that women from Yao tribe were less likely to attain secondary and higher education. Elsewhere, the level of education was reported to be associated with higher score for malaria preventive action [19].

Strengths And Limitations
The study used nationally representative datasets hence findings can be generalized to Malawian women. Further, as this is the first study to evaluate knowledge levels regarding malaria, it may serve to inform public health programs for the need to scale-up efforts in improving malaria knowledge so as to complement other prevention strategies that are being implemented at national level. A number of issues were considered when evaluating knowledge levels including causes, symptoms as well as prevention measures hence providing a more comprehensive information regarding malaria knowledge among Malawian women. However, as this was a cross-sectional study, causal inference could not be drawn.

Conclusions
We found out that the levels of knowledge were moderate among women of reproductive age, which implies that the knowledge related to malaria should be upgraded. Transmission of malaria can be best controlled by concentrating behavioral tailored interventions so as to improve the knowledge of malaria especially for younger women, women with no formal education, women whose households have no media, women from Yao tribes and rural dwellers.

Declarations

Abbreviations
The 2017 MMIS data is available for public use upon request from the Measure Demographic and Health Survey (Measure DHS Program). The 2017 MMIS the survey was implemented by the by the Malawi National Malaria Control Programme (NMCP) while the ICF offered technical assistance through The DHS Program. The 2017 MMIS received ethical clearance from the Malawi National Health
Sciences Research Committee (NHSRC) and the Institutional Review Board (IRB) of ICF Macro. An IRB of ICF Macro ensured that the 2017 MMIS was conducted in line with the U.S. Department of Health and Human Services regulations for the protection of human subjects (45 CFR 46) [23], while the NHSRC certified that the survey was executed in line with Malawian laws and norms. Furthermore, before the interviews, verbal informed was obtained from the heads of the household to participate in the household questionnaire, and each eligible woman to participate in the women’s questionnaire. Participants were assured that participation in 2017 MMIS was voluntary and that no punishment would be given if they choose not to participate or stop answering questions.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and/or analyzed during the current study are available in the MEASURE DHS repository; https://dhsprogram.com/data/

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

All authors contributed to the conception and design of the study. P.A.M.N., acquired data and conducted analysis. P.A.M.N., A.S., and D.P.M., interpreted the results. P.A.M.N., A.S., C.M. and O.N., drafted the first article. D.P.M., G.C.C., and E.B.M., revised the draft critically for important intellectual content. All authors read and approved the final draft.

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