

1 **Demand for family planning satisfied with modern methods in urban Malawi: CHAID**
2 **analysis to identify predictors and women underserved with family planning services**

3
4 **Nurudeen Alhassan^{1*} and Nyovani Janet Madise¹**

5 ¹African Institute for Development Policy (AFIDEP)

6 ***Corresponding author details**

7 Nurudeen Alhassan

8 Petroda Glass House

9 Plot 4/191

10 P. O. Box 31024

11 Lilongwe, Malawi

12 **Email addresses**

13 **NA:** nurudeen.alhassan@afidep.org

14 **NJM:** nyovani.madise@afidep.org

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16 CHAID

17 **Abstract**

18 **Introduction:** Family planning progress under the SDGs is measured with a novel indicator,
19 demand for family planning satisfied with modern methods (mDFPS), which provides a
20 better indication of modern contraceptive coverage than unmet need and contraceptive
21 prevalence rate. Yet, few studies have examined the predictors of mDFPS and the sub-
22 groups of women with unsatisfied mDFPS in urban Saharan Africa. The objective of this
23 study was to examine the predictors of mDFPS in urban Malawi and to identify the sub-
24 groups of urban women underserved with modern contraceptives.

25 **Methods:** The study analysed data from the 2015-16 Malawi Demographic and Health
26 survey. The sample comprised of 2,917 women in urban Malawi who had a demand for
27 family planning services. We used a Chi-square (χ^2) Automatic Interaction Detector (CHAID)
28 model to address the study objectives.

29 **Results:** The results show that the number of living children a woman had was the most
30 significant predictor of mDFPS. Women with one or more children, who were of Chewa,
31 Lomwe or Tumbuka ethnic origin, and who resided in the central region had the highest
32 mDFPS (87%). On the other hand, women with no children, and who were not exposed to
33 FP information on television had the lowest mDFPS (41%). Among women in union,
34 ethnicity was the best predictor of mDFPS. Ngoni, Yao and other ethnic minority women in
35 union who were aged 15-19 and 40 years and above, and who were Catholic, SDA/Baptist or
36 Muslim had the lowest mDFPS (36%).

37 **Conclusion:** This study demonstrates significant intra-urban disparities in demand for FP
38 satisfied with modern contraceptives in Malawi. There is the need for policy makers and
39 reproductive health practitioners to recognise these disparities and to prioritise the
40 underserved groups identified in this study.

41 **Introduction**

42 Modern contraceptive use is effective for preventing unplanned pregnancies and helping
43 individual women and couples to decide freely and responsibly if, when, and how many
44 children they want to have (1,2). Since the adoption of the Programme of Action of the
45 International Conference on Population and Development (ICPD PoA) in 1994, the provision
46 of safe, effective and affordable methods of contraception has been an integral part of the
47 efforts to promote sexual and reproductive health and empower women and girls,
48 particularly in Low and Middle Income Countries (LMIC)(3). Access to modern
49 contraceptives has also been shown to contribute to poverty reduction through
50 improvement in educational outcomes and economic opportunities for women and girls (4–
51 6). Given these extensive benefits, the global community and many national governments
52 have, over the years, undertaken policy actions and made investments to increase access to
53 family planning (FP) services. These efforts, including the Sustainable Development Goals
54 (SDGs), the FP2020 Initiative, and the Maputo Protocol, have resulted in significant
55 increases in contraceptive use in many parts of the world, with the global contraceptive
56 prevalence rate increasing from 35% in 1970 to 63% in 2017(1). Even though contraceptive
57 use in Africa has increased steadily, prevalence is still only 36% which is about half of the
58 global average (1).

59 To monitor progress in contraceptive coverage, several indicators and measures have been
60 adopted under various global development initiatives including contraceptive prevalence
61 rate (CPR) and unmet need for FP. Contraceptive prevalence rate and unmet need were the
62 main FP indicators used to measure progress in target 5B of the Millennium Development
63 Goals (MDGs), to “achieve, by 2015, universal access to reproductive health”. While these
64 indicators remain useful, progress in FP targets under the SDGs is being measured with a
65 novel indicator, demand for FP satisfied with modern contraceptive methods (mDFPS). This
66 indicator is defined as the proportion of women using modern contraceptives among those
67 in need of contraception (7,8). Compared to unmet need and contraceptive prevalence,
68 mDFPS provides a better indication of modern contraceptive coverage as the denominator
69 for its estimation is limited to sexually active women of reproductive age in need of
70 contraception(7).

71 Despite providing a better indication of modern contraceptive coverage and being the main
72 FP indicator for measuring progress in the SDGs, very few studies have examined the
73 predictors of mDFPS within LMICs and the women whose demand for FP is not being
74 satisfied with modern methods(7,9). Many of the studies on mDFPS have focused on macro
75 level analysis at the global level, among LMICs and also at the sub-Saharan African regional
76 level(1,2,7,8,10). The few studies at country level have focused on rural areas where the
77 mDFPS coverage is generally low (9). To the best of our knowledge, no study to date has
78 examined mDFPS in an urban setting in sub-Saharan Africa where contraceptive coverage is
79 fairly high relative to rural areas. Yet, such a study will contribute to understanding intra-
80 urban disparities in modern contraceptive coverage and the categories of urban women
81 whose demand for FP is not being satisfied with modern methods. With majority of Africa’s

82 population projected to live in urban areas by 2050(11), understanding and addressing
83 intra-urban disparities in mDFPS will be critical for managing the adverse effects of having
84 so many urban dwellers. Urban populations are also more diverse in terms of ethnicity,
85 education, wealth, etc. than rural areas; therefore disparities in mDFPS are wide and
86 complex.

87 This study examines mDFPS in an urban setting in sub-Saharan Africa, Malawi. The study will
88 help policymakers and reproductive health practitioners in Malawi to identify and prioritise
89 urban women underserved with modern contraceptives, in the spirit of “leaving no one
90 behind”. The study has two specific objectives: (a) examine the predictors of mDFPS in
91 urban Malawi and (b) identify the sub-groups of urban women whose demand for FP is not
92 being satisfied with modern contraceptives.

93 **Contraceptive Use Context in Urban Malawi**

94 The Republic of Malawi is a landlocked country in southeast Africa, with an estimated
95 population of 17.5 million in 2018(12). The National Statistical Office (NSO) of Malawi
96 defines urban areas on the basis of concentration of non-agricultural activities such as
97 trading and manufacturing, population density, level of service delivery and a minimum
98 total population of 5000 people (13). It is estimated that 16% of the total population of
99 Malawi live in urban areas, making it one of the least urbanised countries in the world
100 (12,14). Nevertheless, the country is urbanising rapidly at a rate of 4.2 %, higher than the
101 average for sub-Saharan Africa(15). The urban population has been projected to reach 12.4
102 million by 2050, from 2.7 million in 2014 (15). Malawi’s urban population is concentrated in
103 four major cities; Blantyre, Lilongwe, Mzuzu and Zomba which account for 75% of the urban
104 population(12). The rapid urbanisation in Malawi is mainly driven by high fertility in urban
105 areas and rural-urban migration. For example, the mean number of children ever born to
106 women age 40-49 years in urban areas is 4.6 children (16).

107 Even though urban infrastructure and service provision in Malawi is less developed
108 compared to countries such as Kenya and South Africa, the urban population still has better
109 access to social services relative to their rural counterparts. For example, 42% of the urban
110 population has access to electricity compared to just 4% in rural areas(17). Urban residents
111 also have better access to healthcare services including reproductive health compared to
112 rural residents. For instance, while the urban population makes up 16% of the total
113 population, 40% of private health facilities are located there and a further 13% in peri-urban
114 areas, with just 47% in rural areas(18). These rural-urban disparities in access to critical
115 social services especially healthcare translate into an urban advantage in access to modern
116 contraceptives. Approximately 78% of demand for FP among married women in urban areas
117 is satisfied with modern methods compared to 74% in rural areas (16). However, this
118 apparent urban-advantage represent aggregate levels which mask intra-urban differentials.
119 Yet, little is known of the disparities in demand for FP satisfied with modern methods in
120 urban Malawi. This study therefore sought to fill this knowledge gap and to help
121 policymakers and reproductive health practitioners to identify the predictors of mDFPS and

122 the sub-groups of urban women whose demand for FP remains unsatisfied with effective
123 modern methods.

124 **Methods**

125 **Study design and data**

126 The current study analysed data from the 2015-16 Malawi Demographic and Health Survey
127 (16). This was a nationally representative survey conducted by NSO in collaboration with the
128 DHS Programme. A two-stage stratified sampling technique was used to select a total of
129 25,146 eligible women for the survey. A detailed description of the sampling procedure for
130 the survey is available in the final report of the survey (16). Of the 25,146 women eligible to
131 be interviewed, 24,562 were actually interviewed. This comprised of 5,247 women in urban
132 areas and 19,315 in rural areas. In this paper, we analysed data from a sub-sample of 2,917
133 urban women who had a demand for family planning. This sample was made of 2,371
134 women currently in union (married/living with a partner) and 546 unmarried (never
135 married/formerly married) women who had sex one month preceding the survey. For the
136 bivariate analysis, we weighted the data to take into account unequal sampling
137 probabilities, and we also took into account the complexity (clustering and stratification) of
138 the DHS sampling design. In DHS surveys, the sample is usually selected with unequal
139 probability to expand the number of cases available for certain areas or population sub-
140 groups for which data is needed. Weights therefore need to be applied when tabulations
141 are made to produce accurate representation.

142 **Study variables**

143 The dependent variable for this study was demand for family planning satisfied with modern
144 contraceptives (mDFPS). This variable (mDFPS) was calculated based on the 2012 update of
145 the indicator definition by MEASURE DHS (19). The numerator for mDFPS was the number
146 of reproductive age women, who were either married or unmarried but reported sexual
147 intercourse in the one month preceding the survey, and who were currently using any
148 modern contraceptive method. The denominator was the total number of women in need
149 of contraception. The women in need of contraception included the following:

- 150 a. Fecund women who wanted the next child after 2 years
- 151 b. Fecund women who wanted another child but were undecided on the timing or
152 were undecided if they want another child.
- 153 c. Fecund women who wanted no more children
- 154 d. Pregnant women who wanted the pregnancy later or did not want it at all.
- 155 e. Post-partum amenorrhoeic women who wanted their last birth later or did not want it
156 at all.

157 Women were classified as infecund and therefore did not need contraceptive if they fell into
158 the following categories:

- 159 a. Married for five or more years, had no children in the past 5 years and never used
160 contraception.
- 161 b. Reported that they could not get pregnant
- 162 c. Reported that they were menopausal/hysterectomy or never menstruated

163 d. Had last period more than 6 months and are not post-partum amenorrheic
164 Modern contraceptive methods in this study included contraceptive pills, intrauterine
165 devices (IUD), injectables, condoms (male and female), sterilization (male and female),
166 implants and emergency contraceptives. It is important to note that while Standard Days
167 Method and Lactational Amenorrhea are considered modern methods by the World Health
168 Organisation (WHO) and the Demographic and Health Survey (DHS), we excluded these two
169 methods from our definition of modern methods in this study. We limited our definition of
170 modern methods to biomedical methods that are actively being promoted in Malawi's
171 family policies such as in the Costed Implementation Plan (CIP). Because the use of these
172 two methods is very negligible (less than 0.5%) in the sample, excluding them from the
173 definition of modern methods did not affect our measurement and analysis in anyway.
174 We classified the dependent variable into two categories (Yes/No): women using
175 biomedical modern contraceptive methods among those in need of contraception were
176 considered to have a demand for FP satisfied with modern methods (Yes) while those not
177 using any method and those using traditional methods including periodic abstinence,
178 withdrawal, standard days method and lactational amenorrhea among those in need of
179 contraception were considered to have an unsatisfied mDFPS (No).
180 The predictor variables included socio-demographic and reproductive characteristics of the
181 women as well as characteristics of their partners for those in union (Tables 1&2). These
182 characteristics included age, number of living children, highest educational attainment,
183 wealth quintile, religious affiliation, ethnicity, region of residence, employment status, and
184 exposure to family planning information on radio, TV, in newspapers/magazines or at health
185 facilities. For the women in union, we also included as predictors the age at first marriage,
186 age difference with their partners, partner's highest education, partner's employment
187 status and the partner's fertility preference.

188 **Statistical analysis**

189 We used descriptive statistics (percentages) to assess the dependent (mDFPS) and predictor
190 variables that were used for the Pearson's χ^2 and the χ^2 Automatic Interaction Detector
191 (CHAID) analyses. Pearson's χ^2 test was performed to examine the associations between
192 mDFPS and key background characteristics of the women. CHAID analysis was then used to
193 examine the significant predictors of mDFPS, and to identify the subgroups of urban women
194 whose demand for FP remains unsatisfied with effective modern methods. CHAID is a
195 methodological approach that is rarely used in family planning research. However, as a
196 predictive model that outlines variables that have the strongest impact on group
197 differentiation, CHAID is more sophisticated than conventional logistic regression which is
198 often used in family planning studies. CHAID analysis also allows for the identification of
199 characteristics that define groups and sub-groups. It is these advantages of CHAID that
200 informed the decision to use it, as it is more appropriate for the objectives of this study.
201 CHAID is a non-parametric and non-linear decision tree algorithm that makes no
202 distributional assumption on outliers, collinearities, heteroscedasticity or distributional
203 error structures. The dependent variable in CHAID analysis can be nominal, ordinal or

204 interval. Unlike regression models where statistical effects are fitted simultaneously, CHAID
205 uses a sequential fitting method where the effects of later statistical tests are dependent on
206 earlier ones. At each stage in this sequence, the predictor variable(s) with the strongest
207 association to the dependent variable is selected. The process continues until all significant
208 predictors have been identified. The predictor variable with the strongest association to the
209 dependent variable is usually the first branch in a tree-like model, with leaves representing
210 categories that are significantly different relative to the dependent variable. The dataset is
211 then further categorised into subgroups according to this first predictor variable, with the
212 most significant combination of variables selected.

213 The output of a CHAID prediction model is a hierarchical tree-like diagram which consists of
214 several level of branches referred to as nodes: root node, parent node, child nodes and
215 terminal nodes. Node splitting is obtained by selecting and using the predictor variable with
216 the most significant p-value as a node separator in each stage of the analysis. This is done by
217 comparing p-values of each predictor variable in the previous stage. This process of node
218 splitting continues until there is no predictor variable with the most significant p-value (ref.).
219 The root node (node 0) is the dependent variable, in this study mDFPS. Parent nodes are in
220 the upper level of the hierarchical structure compared to nodes in the subsequent lower
221 levels. The lower level nodes are referred to as child nodes while terminal nodes are the last
222 categories of the CHAID analysis tree. Terminal nodes do not have child nodes. Each node
223 provides the number and percentage of people in a selected category or subgroup. Chi-
224 square statistics and p-values associated with statistical test at each level of the CHAID
225 model are also calculated and presented in the tree-structured diagram. The p-values in this
226 analysis were adjusted using a Bonferroni correction, meaning the level of significance has
227 been corrected for the several tests of independence performed simultaneously between
228 the predictor variables and the outcome. Using Bonferroni correction to adjust p-values
229 reduces the likelihood of committing a type I error. All analyses for this paper were
230 conducted using SPSS V.20.

231

232 **Results**

233 **Description of women in need of contraception in Malawi, nationally and in urban areas**

234 Table 1 presents the characteristics of all women with demand for contraception nationally
235 and in urban areas of Malawi. Nationally, approximately 74% of women with demand for
236 contraception were using modern methods. Demand for FP satisfied with modern methods
237 was slightly higher in urban areas, with a little over three-quarters of the urban women
238 using modern methods. The mean age of women with demand for contraception
239 nationwide and in urban areas was similar, 30 years. The level of education of urban women
240 with demand for FP was higher than the level nationally, with 4% of the urban women
241 having no education compared to 13% nationwide. However, the percentage of
242 unemployed women in urban areas (39.6%) was higher than the percentage nationwide
243 (31.6%). The percentage of women with no children in urban areas was higher than the
244 percentage nationally. About 13% of the urban women had five or more children compared

245 to a quarter of all women in Malawi. The proportion of urban women exposed to FP
246 information on radio, TV, in newspapers/magazines or at health facilities was higher in
247 urban areas than the proportion nationwide.

248 **[Table 1 about here]**

249 Given that marriage and sexual unions affect contraceptive use in various ways including
250 through spousal influence, we anticipated that the predictors of mDFPS may be different for
251 women in union. We therefore also conducted analyses with the sub-sample of women in
252 union. Table 2 presents the characteristics of women in sexual unions with demand for
253 contraception nationally and in urban areas. Nationwide, approximately three-quarters of
254 married women with demand for contraception were using modern methods. The
255 percentage of married women in urban areas with demand for contraception that were
256 using modern methods was slightly higher (77%) than nationally. More than half (51%) of
257 the women in union nationally entered into their first union as children (below age 18 years)
258 while 37% of the urban women in union were married as children. Approximately 60% of
259 women nationwide had the same fertility preference as their partners compared to two-
260 thirds of urban women. As high as 12% of married women with demand for contraception
261 nationally did not know the fertility preference of their partners. Among married women in
262 urban areas, that figure was 9%.

263 **[Table 2 about here]**

264 **Factors associated with demand for FP satisfied with modern methods in urban Malawi**

265 Table 3 presents the factors associated with demand for FP satisfied with modern methods
266 among all women in urban Malawi. The results showed that seven factors were significantly
267 associated with mDFPS; age, ethnicity, region, marital status, employment status, number
268 of living children and exposure to FP information in a health facility.

269 **[Table 3 about here]**

270 Demand for FP satisfied with modern methods was high among women aged 25-29 years
271 (79%) and low among women aged 15-19 years (63%) and those aged 40-44 years (68%).
272 With regards to ethnicity, mDFPS was higher among Chewa (82%), Lomwe (79%) and
273 Tumbuka (79%) women and lower among Yao (70%), Ngoni (71%) and other minority
274 women (71%). mDFPS was higher among women in the central region (79%) and lower in
275 the northern region (70%). Women who had never been in a marital union (59%) had a
276 lower mDFPS compared with those that were currently in union and those formerly
277 married. Furthermore, 79% of women in employment had their demand for FP satisfied
278 with modern methods compared with 72% among unemployed women. Moreover, mDFPS
279 was highest among women with one or two children (79%) and very low among those with
280 no children (49%). Contrary to expectation, mDFPS was higher among women that did not
281 receive FP information in a health facility and lower among those that received such
282 information in a health facility and those that did not visit health a facility.

283 **Results of CHAID analysis for all urban women with demand for contraception**

284 Figure 1 presents results of the CHAID analysis for all urban women with demand for
285 contraception. The results showed that the number of living children a woman had was the
286 most significant predictor of mDFPS ($\chi^2=75.56$, $p=0.000$). This variable was spilt into two
287 nodes. Node 1 consisted of women of with one or more living children while node 2 was
288 made of women with no children.

289 ***Node 1: Women with one or more children***

290 For this subgroup of women who constituted approximately 93% of the sample, ethnicity
291 was the strongest predictor of mDFPS ($\chi^2=30.60$, $p=0.000$). About 79% of the demand for FP
292 among these women was satisfied with modern methods. The next most important variable
293 for this group of women, ethnicity, was spilt into subgroups: Chewa, Tumbuka, Lomwe
294 (node 3) and Ngoni, Yao and Other (node 4). Women in the Chewa, Tumbuka and Lomwe
295 subgroup (node 3) had 84% of their demand for FP satisfied with modern contraceptives.
296 However, those in the Ngoni, Yao and other ethnic groups had 73% of their demand for FP
297 satisfied with modern methods. For women in the Chewa, Tumbuka and Lomwe subgroup,
298 region of residence was the next best predictor of mDFPS ($\chi^2=13.30$, $p=0.001$). Women in
299 the northern and southern regions (node 7) had 79% of their FP demand satisfied with
300 modern methods compared to 87% among those in the central region.

301 Among Ngoni, Yao and women of other minority ethnic groups, exposure to FP information
302 via text messages on phone was the strongest predictor of mDFPS ($\chi^2=16.04$, $p=0.000$). Only
303 about 58% of the women who received FP information via text messages on their phones
304 (node 9) had their demand for FP satisfied with modern methods compared to
305 approximately 76% of those that did not (node 10).

306 **[Figure 1 about here]**

307 ***Node 2: Women with no children***

308 Only 48% of the women with no children had their demand for FP satisfied with modern
309 contraceptives. Among these women, exposure to FP information on TV was the best
310 predictor of demand for FP satisfied with modern methods ($\chi^2=7.27$, $p=0.007$). Close to two-
311 thirds (64%) of the women who watched FP information/messages on TV in the last few
312 months had their demand for FP satisfied with modern contraceptives compared to about
313 just 41% of those that did not.

314 **[Table 4 about here]**

315 **Results of CHAID analysis for urban women in union with demand for contraception**

316 The results of the CHAID analysis for urban women in union with demand for contraception
317 are presented in figure 2. The results showed ethnicity as the most significant predictor of
318 mDFPS among urban women in union ($\chi^2=32.07$, $p=0.000$). Chewa, Lomwe and Tumbuka
319 (node 1) women in union had 83% of their demand for FP satisfied with modern methods
320 compared to about 72% among Ngoni, Yao and women of other minority ethnic groups such
321 as Nkhonde and Sena (node 2).

322 ***Node 1: Chewa, Lomwe and Tumbuka women in union***

323 This sub-group of women constituted 56% of the total sample of women in union. Among
324 these women, the highest educational attainment of their partner was the best predictor of
325 mDFPS ($X^2=20.56$, $p=0.000$). The educational attainment of their partners was further split
326 into two sub-groups: women with partners of secondary and higher education (node 3), and
327 those with partners of no education and primary education (node 4). Contrary to
328 expectation, as high as 92% of women whose partners had no education or primary
329 education had their demand for FP satisfied with modern contraceptives compared to about
330 80% of those whose partners had secondary and higher education.
331 Among women whose partners had secondary or higher education, household wealth
332 quintile was the best predictor of mDFPS ($X^2=23.26$, $p=0.000$). In this sub-group, women in
333 the richest, poorer and poorest (node 7) households had a demand for FP satisfied with
334 modern methods (86%) that was 15% higher than those in the richer and middle households
335 (71%). For the women whose partners had no education or primary education (node 4), the
336 fertility preference of the couple was the most significant predictor of mDFPS ($X^2=18.93$,
337 $p=0.000$). Women who had the same fertility preference as their partners had about 83% of
338 their demand for FP satisfied with modern methods while women whose husbands wanted
339 more and those whose husbands wanted fewer children had 94% of that demand satisfied.
340 Unexpectedly, all the women (100%) who did not know the fertility preference of their
341 partners had their demand for FP satisfied with modern methods.

342 **[Figure 2 about here]**

343

344 ***Node 2: Ngoni, Yao and Other women in union***

345 As indicated previously, about 72% of Ngoni, Yao and other women of minority ethnic
346 groups in union had their demand for FP satisfied with modern methods. Among these
347 women, age was the most significant predictor of mDFPS ($X^2=26.83$, $p=0.000$). Age was
348 further split into two sub-groups: 20-24, 25-29, 30-34, 35-39 (node 5) and 15-19, 40-44, 45-
349 49 (node 6). The mDFPS among women aged 20-24, 25-29, 30-34 and 35-39 years was about
350 76%. This reduced significantly to 54% among women aged 15-19, 40-44 and 45-49 years.
351 For the women aged 20-24, 25-29, 30-34 and 35-39 years, the most significant predictor of
352 mDFPS was exposure to FP information through text messages on phone ($X^2=7.30$, $p=0.007$).
353 About two-thirds (64%) of the women who received FP information via text messages had
354 their demand for FP satisfied with modern methods compared to more than three-quarters
355 of those that did not. Among the women aged 15-19, 40-44 and 45-49 years, religious
356 affiliation was the best predictor of mDFPS ($X^2=13.97$, $p=0.006$). Approximately 68% of
357 Anglican, CCAP and Other Christian women had their demand for FP satisfied with modern
358 methods compared to just 36% among Catholic, SDA and Muslim women.

359 **[Table 5 about here]**

360

361 **Discussion**

362 The objective of this study was to examine the predictors of demand for FP satisfied with
363 modern methods (mDFPS) in urban Malawi and to identify the sub-groups of urban women
364 underserved with modern contraceptives. The study analysed data from the 2015-16
365 Malawi DHS data, using a CHAID decision tree analytic technique. The results for the full
366 sample showed that demand for FP satisfied with modern methods was higher among
367 women with children, Chewa/Tumbuka/Lomwe women, and women residing in the central
368 region. The least demand satisfied with modern methods was among women with no
369 children, and who had not heard FP advertising on television.

370 The most significant predictor of demand for FP satisfied with modern methods was the
371 number of living children women had. The women with no children had a lower demand
372 satisfied with modern methods relative to those with children. This finding is consistent with
373 the results of previous studies conducted in sub-Saharan Africa and LMICs(20,21). One study
374 in Zimbabwe found that women with no children were eight times less likely to use modern
375 contraceptives compared to those with one or more children(21). A plausible explanation of
376 the finding in this study is that the desire to postpone first birth is weakly held among
377 women with no children. Thus, the motivation to use modern contraceptives to satisfy their
378 demand for FP is low. It is also likely that most of the women with no children are younger,
379 and therefore face several barriers to accessing modern contraceptives. Encouraging
380 women to postpone first birth and addressing both the demand and supply factors that
381 inhibit women with no children from using modern contraceptives need to be prioritised if
382 Malawi is to close the mDFPS gap between these women and their peers with one or more
383 children.

384 The results also showed ethnicity as a significant predictor of mDFPS, and ethnicity was
385 significant for women with one or more children. Chewa, Lomwe and Tumbuka women who
386 had at least one living child had a higher mDFPS than Yao, Ngoni and other ethnic minority
387 women. Yaos ascribe to matrilineal descent and are predominantly muslim, with
388 conservative cultural norms that value sexual initiation ceremonies, early marriages and
389 large families(22). With regards to the Ngoni, patrilineal descent where children are
390 affiliated to their fathers' kin group is a major cultural feature. It is known that women in
391 patrilineal descent systems have limited autonomy in decision making regarding
392 childbearing(23). The above cultural norms probably inhibit modern contraceptive use
393 among Yao and Ngoni women. Women of minority ethnic groups such as the Nkhonde and
394 Sena also probably face difficulties in accessing FP services due to language barriers or
395 discrimination by contraceptive service providers. There is the need for further studies to
396 investigate cultural norms, beliefs and other factors that constrain modern contraceptive
397 use among Yao, Ngoni and other ethnic minority women in urban Malawi.

398 The analysis further showed region of residence as the most significant predictor of mDFPS
399 among Chewa, Lomwe and Tumbuka women. Women residing in the central region had a
400 significantly higher mDFPS than those in the southern and northern regions. A plausible
401 explanation of this finding is the low concentration of health facilities especially facilities
402 that offer reproductive services in the northern and southern regions. For example, one

403 study that mapped private health facilities, which are crucial for expanding access to FP
404 services, in Malawi found that only 14% of private facilities with nurse midwives were
405 located in the northern and southern regions respectively compared to 71% in the central
406 region. Astonishingly, there were no private mobile clinics in the northern region and only
407 33% of such facilities were in the southern region compared to 67% in the in the central
408 region(18).

409 Exposure to FP information via text message(s) on phone was the most significant predictor
410 of mDFPS among Ngoni, Yao and women of other minority ethnic groups. Unexpectedly, it
411 was observed that the women that were exposed to FP information via text messages had a
412 lower mDFPS than those that were not. Specifically, about 58% of the Ngoni, Yao and
413 women of other ethnic groups that had accessed FP information via text messages on
414 phone had their demand for FP satisfied with modern methods compared to approximately
415 76% of those that did not. Even though FP programmes are increasingly taking advantage of
416 the ubiquity of mobile phones in sub-Saharan Africa to deliver contraceptive information via
417 text messages to women and couple, there is little evidence of the effect of such
418 interventions on contraceptive uptake. One study that evaluated the impact of a mobile
419 reproductive health platform in Kenya (m4RH) which delivered contraceptive information
420 via text messages found an increase in m4RH consumers' contraceptive knowledge, but
421 there was no increase in contraceptive use among them(24). While we are not sure of the
422 source(s) of the text messages delivered to the women in the current study, it is possible
423 that these messages reinforce misconceptions about FP, and therefore discourage modern
424 contraceptive use. It is known that the emergence of social media platforms including
425 WhatsApp and Facebook messenger allow for the easy circulation of unreliable information
426 from dubious sources including information on FP. It is also possible that this
427 counterintuitive finding is a spurious one due to the omission of an important variable in the
428 analysis, a common pitfall of CHAID and other multivariate analytic techniques. It is likely
429 that most women that access FP information via text messages are those with a weak
430 motivation to use modern methods due to fear of side effects. There is the need for further
431 studies to investigate the content, sources and effect of such messages in Malawi and Africa
432 at large.

433 As shown in the results, women with no children are severely underserved with FP services,
434 with only 48% of them having their demand for FP satisfied with modern methods. Among
435 these women, exposure to FP information on TV was the best predictor of mDFPS.
436 Approximately two-thirds of the women with no children who were exposed to FP messages
437 on TV had their demand for FP satisfied with modern methods compared to 4 in 10 of those
438 that were not exposed to FP messages on TV. Contrary to the results on the effect of
439 exposure to FP information via text messages, this finding suggests that viewing FP
440 messages on TV improves the chances of using modern contraceptives. Television is a
441 credible source of information in the Malawian context, thus FP information on TV is more
442 likely to be accurate, create awareness, increase knowledge and induce contraceptive use.

443 For the women in union, the results showed that demand for FP satisfied with modern
444 methods was highest among Chewa, Tumbuka and Lomwe women whose partners had
445 primary or no education, and who did not know the fertility preference of their partners.
446 The least demand satisfied with modern methods was among Ngoni, Yao and other ethnic
447 minority women who were aged 15-19 and 40 years and above, and were Catholic,
448 SDA/Baptist or Muslim.

449 Overall, ethnicity was the strongest predictor of mDFPS among women in union. Similar to
450 the results for the full sample, Chewa, Lomwe and Tumbuka women in union had a higher
451 mDFPS than Ngoni, Yao and women of other minority ethnic groups. The fact that ethnicity
452 was the most significant predictor of mDFPS among women in union suggests that socio-
453 cultural norms that influence women's contraceptive use behavior are at their strongest in
454 sexual unions. Efforts to address sociocultural norms inhibiting women's use of modern
455 contraceptives in urban areas in Malawi need to prioritise those in union, especially Ngoni,
456 Yao and women of other minority ethnic groups.

457 Contrary to expectation, the results showed that Chewa, Lomwe and Tumbuka women
458 whose partners had no education or primary education had a significantly higher mDFPS
459 than those with partners of secondary and higher education. Even though previous studies
460 in LMICs show a strong positive association between educational attainment and modern
461 contraceptive use, there is evidence that better educated women in urban sub-Saharan
462 Africa consistently report higher use of traditional methods than their less-educated peers
463 (27). While most of the studies reporting high traditional method use among better
464 educated urban women do not include the educational attainment of their partners, it is
465 likely that partners with secondary and higher education disapprove of modern methods
466 due to side effects. It is also possible that FP programmes in urban Malawi are focusing less
467 on couples of higher socio-economic status including women with partners of secondary
468 and higher education because of the wrong assumption that such women are already
469 contracepting or have fewer barriers to accessing modern contraceptive methods.

470 Furthermore, the study found that household wealth status was the most significant
471 predictor of mDFPS among women with partners of secondary and higher education.
472 Counterintuitively, women in the poorer and poorest categories together with those in the
473 richest category had a mDFPS that was 15% higher than their peers in the richer and middle
474 categories. The bivariate analysis (table 4) showed no statistically significant difference
475 between rich and poor women in mDFPS, even though the percentages in the poorer and
476 poorest categories was higher than richer and richest. Research in the slums of Kenya has
477 shown that the gap between rich and poor women in terms of access to modern
478 contraceptives has narrowed significantly to a point where there is virtually no difference
479 (ref.). The narrowing of this gap in Kenya is explained by increasing focus of family planning
480 and reproductive health programmes on urban poor, marginalised and hard-to-reach urban
481 women. Malawi's Family Planning Costed Implementation Plan also identifies urban poor
482 women as one of special sub-groups to focus for increased uptake of modern methods. It is
483 possible that this programmatic focus on urban poor has resulted in them having a higher

484 mDFPS. Furthermore, it is important to note that other factors including the motivation for
485 contraceptive use and fear of side effects which were not included in this study determine
486 women's capacity to satisfy their demand for FP with modern methods. It is therefore
487 possible that the omission of these key factors has resulted a spurious relationship between
488 household wealth and mDFPS. There is the need for further studies to investigate the
489 counterintuitive relationships between socio-economic status and mDFPS observed in this
490 study.

491 For the women whose partners had no education or primary education, the fertility
492 preference of the couple was the most significant predictor of mDFPS. Women who had the
493 same fertility preference as their partners had a lower mDFPS relative to those whose
494 partners wanted more or fewer children and those who did not know the fertility
495 preference of their partners. Research on fertility preference in Malawi shows that couple
496 with the same fertility preference are those who tend to want a child in the next three
497 years(28). This suggests that the women reporting the same fertility preference as their
498 partners in this study are those wishing to postpone or space pregnancy/childbirth but not
499 to stop. In such instances, women are typically less likely to use modern contraceptives to
500 satisfy their demand(28,29). Interestingly, we also found that all the women that did not
501 know the fertility preference of their partners had their demand for FP satisfied with
502 modern methods. This suggests that when women do not know the fertility preference of
503 their partners they assume lack of or less opposition from those partners on modern
504 contraceptive use, and are therefore likely to have their demand for FP satisfied with
505 modern methods.

506 As shown in the results, Ngoni, Yao and other ethnic minority women in union who were
507 aged between 20 and 39 years, the prime reproductive childbearing ages had a significantly
508 higher mDFPS than those aged 15-19, 40-44 and 45-49 years. In general, reproductive
509 health and family planning services in most sub-Saharan African countries including Malawi
510 are not adequately oriented towards meeting the needs of adolescents. Thus, adolescents
511 disproportionately face many barriers in accessing modern contraceptives including stigma,
512 cost of services and lack of adequate knowledge. The finding in this study is therefore
513 consistent with the findings of previous studies in the sub-region.

514 With respect to relatively older women, those aged 40 years and above, studies show that
515 they are among those with the highest demand for FP for stopping childbearing (31). It is
516 likely that most urban women in Malawi aged 40 years and above have already attained
517 their desired fertility, and would therefore like to use long-acting and permanent methods
518 (LAPMs) to stop childbearing. Yet, short-term methods such as pills and injectables which
519 are prone to discontinuation and may not satisfy the peculiar needs of these women are still
520 the dominant modern contraceptive methods in Malawi, with less than 10% of all
521 contraceptive users relying on LAPMs(32,33). One study in the capital of Malawi, Lilongwe,
522 found that majority of the FP clinics did not offer IUD or female sterilization services(33). In
523 addition, relatively older women at the end of their reproductive years are often left out of
524 FP discussions and policies due to the perception, sometimes wrongly, that they are

525 menopausal, have infrequent sex or lack a regular partner. Family planning messages and
526 services are therefore rarely targeted at these women to satisfy their demand.
527 Among the adolescents (15-19 years) and older women (40 years and above) in this study,
528 religious affiliation was the most significant predictor of mDFPS. About 68% of Anglican,
529 CCAP and Other Christian women had their demand for FP satisfied with modern methods
530 compared to just 36% among Catholic, SDA and Muslim women. This finding is consistent
531 with the results of previous studies in Malawi (34–36). Overall, fundamental Catholic,
532 Muslim and conservative protestant denominations such as the SDA believe that it is God
533 who controls the number of children women have. Therefore, modern contraceptive use is
534 viewed as violating or interfering with God’s law on procreation. In Malawi, even in urban
535 areas, where upwards of 90% of women are affiliated with either Christianity or Islam, it is
536 likely that such conservative religious views inform women’s reproductive behaviour,
537 especially contraceptive use. The fact that religion significantly predicted mDFPS among
538 adolescents and older women suggests that religious constraints to modern contraceptive
539 use are particularly severe among these already vulnerable and underserved groups.

540

541 **Limitations of the study**

542 Even though this study is one of the few studies to examine mDFPS among urban women in
543 sub-Saharan African using CHAID analysis, it has two key methodological limitations. Firstly,
544 the study uses cross sectional data from the 2015-16 Malawi Demographic and Health
545 Survey which does not allow for causal inferences to be made from the findings. Secondly,
546 the CHAID analytic technique used does not take into account the hierarchical structure of
547 the Demographic and Health Survey data. In addition to these methodological limitations,
548 the study did not include other factors such as the motivation for contraceptive use and fear
549 of side effects which are known to determine women’s capacity to satisfy their demand for
550 FP with modern methods (ref.). Despite these limitations, the method used in this study
551 revealed a complexity of interactions in the predictors of mDFPS that may be difficult to
552 tease out in conventional regression analysis.

553 **Conclusion**

554 This paper examined the predictors of mDFPS and identified the sub-groups of urban
555 women in Malawi with unsatisfied mDFPS. The results showed that number of living
556 children, ethnicity, region of residence, exposure to FP information via text messages on
557 phone and exposure to FP information on TV were the significant predictors of mDFPS
558 among women in urban Malawi. Among these factors, the number of living children a
559 woman had was the most significant predictor of mDFPS. The findings also revealed that the
560 sub-groups of urban women with unsatisfied mDFPS included women with no children who
561 were not exposed to FP information/messages on TV; Ngoni, Yao and other ethnic minority
562 women who were exposed to FP information via text messages on phone; and Chewa,
563 Lomwe and Tumbuka women living in the northern and southern regions.

564 The disparities in mDFPS observed in this study demonstrates that the apparent urban
565 advantage in modern contraceptive use in Malawi is not uniform across all sub-groups of

566 women. There is therefore the need for policy makers and reproductive health practitioners
567 to recognise these disparities and to prioritise the underserved groups identified in this
568 study. As a matter of priority, policy and programmatic efforts in urban Malawi need to
569 focus on women with no children, especially those without access to FP information on TV.
570 Among women in union, adolescents and women aged 40 years and above who are of
571 Ngoni, Yao and other minority ethnic groups, and who are also Catholic, SDA/Baptist or
572 Muslim need to be prioritised as a matter of urgency. In addition to the policy implications,
573 the study findings raised important and unexplored research questions such as the effect of
574 exposure to FP information via text messages on mDFPS and the effect of partner's
575 education on women's contraceptive uptake in urban Malawi. We therefore suggest further
576 studies to address these research gaps.

577

578 **Abbreviations**

579 mDFPS: Demand for Family Planning Satisfied with Modern Methods

580 CHAID: Chi-square (χ^2) Automatic Interaction Detector.

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585 **Authors' contributions**

586 NA and NJM conceptualised the study and decided on the data analysis. NA drafted the
587 manuscript. All authors read and approved the final draft.

588 **Declaration**

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593 However, the funders had no role in conceptualising, analysing and interpreting the results,
594 and manuscript preparation.

595 **Ethics approval and consent to participate**

596 We sought permission from the DHS program to obtain and analyse this data. This study is
597 based on secondary analysis of the 2015-16 Malawi DHS, therefore ethical approval and
598 consent of respondents to participate in it was not applicable.

599 **Consent for publication**

600 Not applicable.

601 **Competing Interest**

602 The authors declare that they have no conflict of interest.

603

Table 1 Socio-demographic characteristics of women with demand for FP in Malawi

Socioeconomic and demographic characteristics	Percent (%)		Urban Number
	National Weighted	Urban Weighted	
Demand for FP satisfied with modern methods			
Yes	73.9	76.2	2229
No	26.1	23.8	688
Age groups			
15-19	9.2	7.5	242
20-24	21.6	19.1	574
25-29	19.3	22.0	648
30-34	19.1	21.6	573
35-39	15.4	15.5	452
40-44	9.5	9.7	273
45-49	6.0	4.7	155
Highest education			
No education	13.1	4.3	140
Primary	64.3	41.8	1295
Secondary	20.1	43.1	1233
Higher	2.5	10.8	249
Wealth quintile			
Poorest	19.8	19.5	708
Poorer	20.6	20.0	567
Middle	20.5	20.8	550
Richer	19.9	20.3	571
Richest	19.2	19.3	521
Religion			
Catholic	18.0	17.1	483
CCAP	16.8	21.6	592
Anglican	2.5	3.2	140
Seventh Day Adventist/Baptist	6.6	8.4	249
Other Christian	43.7	40.0	1121
Muslim	11.7	9.2	320
No Religion	0.6	0.4	11
Other	0.1	0.0	1
Ethnicity			
Chewa	35.8	24.5	715
Tumbuka	9.1	10.4	339
Lomwe	19.5	20.8	543
Yao	12.4	13.4	338
Ngoni	11.5	17.3	453
Other	11.7	13.7	529
Region			
Northern	11.8	10.3	604
Central	43.4	45.4	1011
Southern	44.9	44.4	1302

Employment status			
Employed	68.4	60.4	1806
Unemployed	31.6	39.6	1111
Marital status			
Never in union	5.9	9.3	276
Currently married	83.8	80.9	2371
Formerly in union	10.4	9.8	270
Number of living children			
No child	5.4	7.3	226
1-2 children	36.9	47.2	1303
3-4 children	33.1	32.6	965
5+ children	24.6	12.8	423
Exposure to FP information on Radio			
Yes	42.9	57.7	1764
No	57.1	42.3	1153
FP information on TV			
Yes	10.0	31.0	863
No	90.0	69.0	2054
FP information in newspaper/magazine			
Yes	8.8	20.1	586
No	91.2	79.9	2331
FP information by text messages			
Yes	5.7	14.0	360
No	94.3	86.0	2557
FP information in health facility			
Yes	23.5	23.5	912
No	39.2	39.2	1103
Did not visit a health facility	37.3	37.2	902

Source: Malawi Demographic and Health Survey, 2015-16

Table 2 Socio-demographic characteristics of married women with demand for FP in Malawi

Socioeconomic and demographic characteristics	Percent (%)		Urban Number
	National Weighted	Urban Weighted	
Demand for FP satisfied with modern methods			
Yes	74.5	77.4	1827
No	25.5	22.6	544
Age groups			
15-19	5.9	3.3	101
20-24	21.5	18.2	431
25-29	20.4	23.9	568
30-34	20.1	22.5	496
35-39	15.8	16.8	405
40-44	10.1	10.5	239
45-49	6.2	4.9	131
Highest education			
No education	13.5	4.3	120
Primary	65.1	42.0	1070
Secondary	19.1	43.1	982
Higher	2.3	10.6	199
Wealth quintile			
Poorest	18.6	19.8	575
Poorer	21.0	20.7	468
Middle	20.9	21.7	444
Richer	20.4	20.4	462
Richest	19.2	17.4	422
Religion			
Catholic	17.5	16.1	383
CCAP	17.1	22.3	491
Anglican	2.4	2.7	100
Seventh Day Adventist (SDA)/Baptist	6.8	8.8	208
Other Christian	44.1	40.0	916
Muslim	11.6	9.6	263
No religion	0.5	0.5	9
Other	0.1	0.0	1
Ethnicity			
Chewa	36.4	23.7	587
Tumbuka	9.7	10.9	289
Lomwe	18.5	20.6	422
Yao	12.0	13.6	264
Ngoni	11.5	17.2	382
Other	11.8	14.1	427
Region			
Northern	12.5	11.0	508
Central	44.3	45.7	839

Southern	43.2	43.4	1024
Employment status			
Employed	68.8	61.0	1501
Unemployed	31.2	39.0	870
Age at first marriage			
Less than 18 years	50.8	37.0	952
18-24 years	45.3	54.1	1261
25+ years	3.9	8.8	158
Number of living children			
No child	1.9	1.5	49
1-2 children	37.3	49.3	1085
3-4 children	34.6	35.9	869
5+ children	26.2	13.3	368
FP information on Radio			
Yes	55.9	59.3	1479
No	44.1	40.7	892
FP information on TV			
Yes	10.0	31.2	718
No	90.0	68.8	1653
FP information in newspaper/magazine			
Yes	8.3	19.5	473
No	91.7	80.5	1898
FP information by text messages			
Yes	5.7	14.5	305
No	94.3	85.5	2066
FP information in health facility			
Yes	34.3	25.5	798
No	35.9	40.3	903
Did not visit a health facility	29.8	34.2	670
Age difference			
1-4 years	43.4	41.0	973
5-9 years	33.8	38.6	890
10/more years	14.7	14.5	380
Same age	4.0	3.2	62
Wife older	4.1	2.8	66
Husband's education			
No education	9.3	2.3	72
Primary	54.2	26.1	693
Secondary	30.1	52.7	1188
Higher	5.3	18.2	393
Don't know	1.1	0.7	25
Husband's employment			
Unemployed	8.6	3.2	112
Employed	90.6	96.3	2240
Don't know	0.8	0.6	19
Husband's fertility desire			

Both want same	59.7	65.5	1317
Husband wants more	18.0	15.6	354
Husband wants fewer	9.9	9.8	155
Don't know	12.4	9.1	208

Source: Malawi Demographic and Health Survey, 2015-16

Table 3. Association between mDFPS and socio-demographic and reproductive characteristics of all urban women in Malawi

Background characteristics	Demand for FP satisfied with modern contraceptives			
	Yes (%)	No (%)	χ^2	p-value
Age				
15-19	62.5	37.5		
20-24	78.9	21.1		
25-29	79.2	20.8		
30-34	78.7	21.3	40.58	0.023
35-39	76.8	23.2		
40-44	68.1	31.9		
45-49	77.0	23.0		
Highest Education				
No education	79.2	20.8		
Primary	79.4	20.6	15.09	0.168
Secondary	74.3	25.7		
Higher	70.8	29.2		
Wealth quintile				
Poorest	77.2	22.8		
Poorer	77.5	22.5		
Middle	77.3	22.7	4.15	0.714
Richer	73.2	26.8		
Richest	76.1	23.9		
Religion				
Catholic	73.3	26.7		
CCAP	79.4	20.6		
Anglican	80.3	19.7	21.59	0.136
SDA/Baptist	70.8	29.2		
Other Christian	78.2	21.8		
Muslim	68.8	31.2		
Ethnicity				
Chewa	82.3	17.7		
Tumbuka	79.4	20.6		
Lomwe	79.4	20.6	41.72	0.011
Yao	70.2	29.8		
Ngoni	70.7	29.3		
Other	71.2	28.8		
Region				
Northern	69.8	30.2		
Central	79.2	20.8	14.76	0.006
Southern	74.7	25.3		
Marital status				
Never in union	59.0	41.0		
Currently married	77.4	22.6	54.68	0.000
Formerly married	83.5	16.5		
Employment status				
Employed	78.8	21.2	16.67	0.007

Unemployed	72.3	27.7		
Number of living children				
No child	48.9	51.1		
1-2 children	78.7	21.3	95.33	0.000
3-4 children	78.5	21.5		
5+ children	77.0	23.0		
FP Information on radio				
Yes	74.6	25.5	6.24	0.084
No	78.5	21.5		
FP Information on TV				
Yes	76.5	23.5	0.05	0.881
No	76.1	23.9		
FP Information in newspaper				
Yes	77.0	23.0	0.22	0.757
No	76.1	23.9		
FP Information via text message				
Yes	72.1	27.9	4.48	0.227
No	76.9	23.1		
FP Information in health facility				
Yes	73.5	26.5		
No	80.4	19.6	18.10	0.030
Did not visit facility	73.6	26.4		

Figure 1 Decision tree diagram for all urban women with demand for modern methods in Malawi

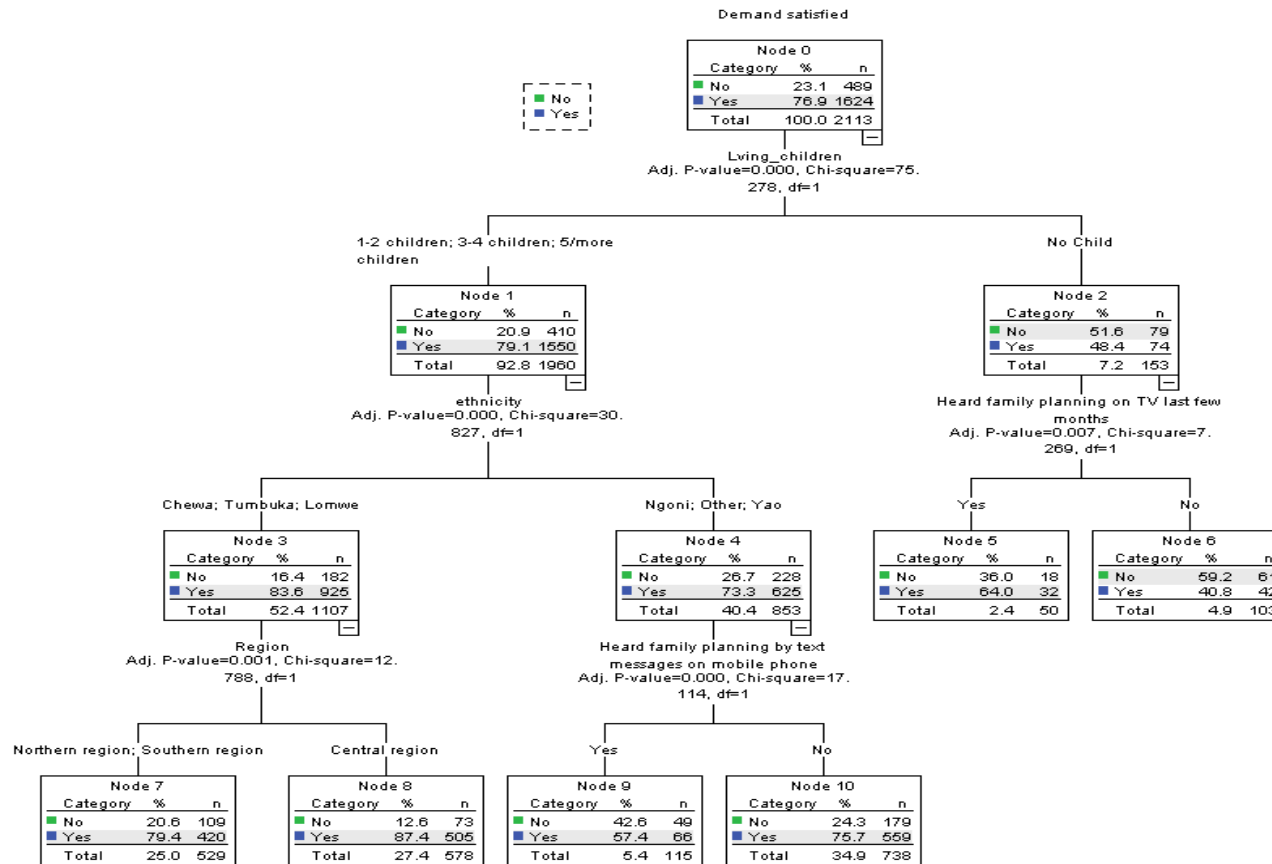


Table 4 Summary information on the specifications used to build the CHAID model

Model Components	Model specification	Results
Dependent variable	Demand for FP satisfied with modern methods	% of women with demand satisfied=76.9
Independent variables	Age, highest education, wealth quintile, religion, ethnicity, region, employment, marital status, exposure to FP information on radio, exposure to FP information on TV, exposure to FP information in newspapers/magazines, exposure to FP information by text messages on mobile phone, exposure to FP information in health facility, number of living children	<i>Number of living children</i> , ethnicity, region of residence, exposure to FP information on TV, exposure to FP information by text messages on mobile phone.
Maximum tree depth	3	3
Minimum cases in parent node	100	100
Minimum cases in child node	50	50
Number of nodes	-	11
Number of terminal nodes	-	6
Overall predicted correct percentage		77.8

Figure 2 Decision tree diagram for married women in urban areas with demand for modern methods in Malawi

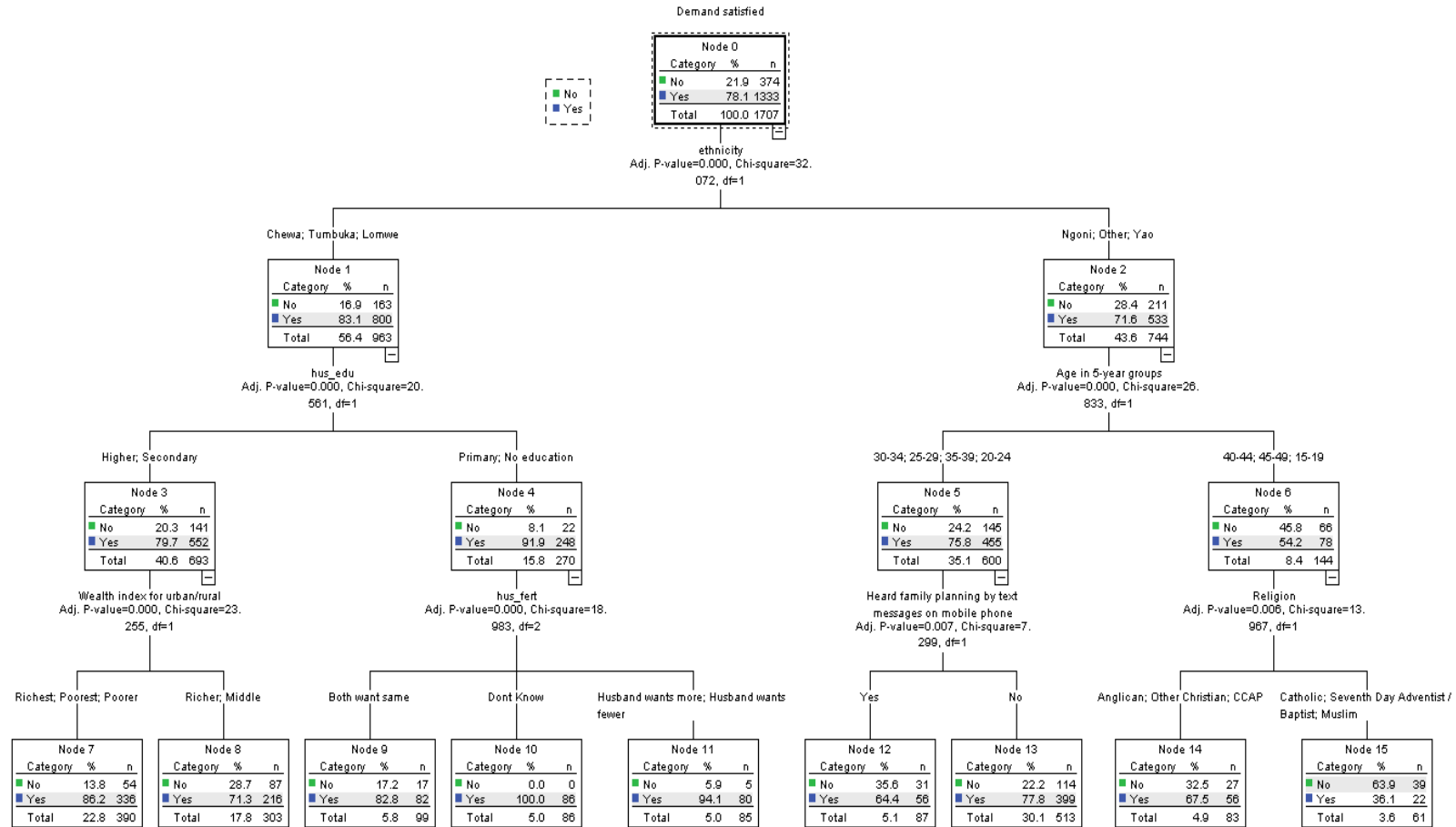


Table 5 Summary information on the specifications used to build the CHAID model

Model Components	Model specification	Results
Dependent variable	Demand for FP satisfied with modern methods	% of women with satisfied demand=78.1
Independent variables	Age, highest education, wealth quintile, religion, ethnicity, region, employment, marital status, exposure to FP information on radio, exposure to FP information on TV, exposure to FP information in newspapers/magazines, exposure to FP information by text messages on mobile phone, exposure to FP information in health facility and number of living children, Age at marriage, Age difference between partners, husband education, husband employment, husband fertility preference	<i>Ethnicity</i> , husband education, wealth quintile, husband's fertility preference, age, exposure to FP information by text messages on mobile phone, religion
Maximum tree depth	3	3
Minimum cases in parent node	100	100
Minimum cases in child node	50	50
Number of nodes	-	16
Number of terminal nodes	-	9
Overall predicted correct percentage		79.1

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