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COMMUNITY IMMUNIZATION CHAMPIONS AND CAREGIVER KNOWLEDGE OF THE SECOND DOSE OF MEASLES-CONTAINING VACCINE IN THE CONFLICT-AFFECTED NORTH WEST REGION OF CAMEROON: A QUASI-EXPERIMENTAL STUDY

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ABSTRACT

Background: Uptake of the second dose of measles-containing vaccine (MR2) lags the first dose in Cameroon's conflict-affected North West Region. Caregivers unaware that a second dose is needed, or when it is due, are unlikely to return. We assessed changes in caregiver knowledge of measles and MR2 after a community immunization champion intervention.

Methods: In this quasi-experimental study, we surveyed households before and after a three-month intervention in six intervention and two control health areas. Trained champions conducted door-to-door sensitization, traced children who missed MR2 and referred caregivers. Caregivers answered six knowledge items (score 0–6; adequate, ≥4). Effects were estimated as differences-in-differences (DiD), overall and by urban or rural setting.

Results: We surveyed 913 caregivers at baseline and 666 at endline. At baseline, 84.3% had heard of MR2, 70.6% knew it was due at 15–24 months, and 47.9% believed one dose was enough. Adequate knowledge rose from 82.7% to 88.6% in the intervention arm and fell from 88.0% to 82.6% in controls (DiD 11.3 percentage points; 95% CI 4.2–18.4). Gains were largest for having heard of MR2 (DiD 17.2; 95% CI 10.4–24.0) and knowing when it is due (DiD 19.0; 95% CI 10.2–

27.8). The effect was confined to rural health areas (DiD 23.1; 95% CI 13.1–33.1; urban DiD −1.1; 95% CI −11.2 to 8.9). Adequate knowledge was independently associated with MR2 uptake (adjusted odds ratio 2.76; 95% CI 1.56–4.87).

Conclusions: Champions were associated with better MR2 knowledge in rural communities, where it was weakest, but not in urban communities.

Keywords: Measles; Second dose of measles-containing vaccine; Community immunization champions; Caregiver knowledge; Conflict-affected setting; Cameroon

1 INTRODUCTION

Measles remains one of the most contagious human infections and a leading vaccine-preventable cause of death in young children [1]. Interrupting transmission requires at least 95% population immunity, which can be reached only with two doses of measles-containing vaccine because some children do not respond to the first dose [2, 3]. In 2025, global coverage was 84% for the first dose and 77% for the second, and 57 countries reported large or disruptive outbreaks [5]. In Cameroon, second-dose coverage of the measles–rubella vaccine (MR2) has risen in recent years but still trailed the first dose (MR1) in 2025, at 66% versus 75% [6], and district surveys recorded MR2 coverage below 50% [7].

The gap between the two doses is a problem of return rather than of first contact. Across sub-Saharan Africa, a child's receipt of the second dose has been associated with the caregiver's knowledge of the vaccination schedule, maternal education, antenatal and postnatal contact with health services, and distance to a vaccination site [8, 9]. Unawareness about the need for a second dose was a leading reason for non-uptake in Tanzania [10], while caregivers who knew the schedule were more likely to complete it in Nigeria [11]. In terms of the Health Belief Model, a caregiver who already regards measles as serious may still see no benefit in a second dose if she believes that one dose protects the child [12]. Knowledge of the second dose is therefore a plausible and modifiable link between the first and second doses.

In the North West Region of Cameroon, the armed conflict that began in 2016 compounded these barriers. Between 2016 and 2019, the proportion of the region's health districts that reached 80% coverage of the third dose of diphtheria–tetanus–pertussis vaccine fell from 75% to 11%, 106 health facilities closed permanently, and outreach sessions fell by 75% [13]. Programme data show that MR2 coverage in the region was between 34% and 57% from 2021 to 2025, with drop-out from MR1 to MR2 well above the 10% that programmes aim for [14].

Community-based approaches address several of these barriers simultaneously. Health education, home visits, reminders, and the engagement of community leaders have each improved childhood immunization coverage in low- and middle-income countries [17–19], and lay and community health workers have increased uptake by building trust, tracing defaulters, and linking households to services [20–22]. Community immunization champions (CICs), trusted community members trained to promote vaccination, combine these elements in a single role [23]. However, most evidence focuses on first doses of the infant schedule or full immunization rather than completion of the second measles dose; it seldom reports caregiver knowledge alongside coverage, and it rarely comes from conflict-affected settings [24–27].

We evaluated a CIC intervention to increase MR2 uptake in the North West Region of Cameroon. This article reports the first objective of the evaluation: to assess caregiver knowledge of measles and MR2 before and after the intervention in intervention and control communities. We also examined whether the effect differed between urban and rural health areas and whether caregiver knowledge was associated with MR2 uptake.

2 METHODS

2.1 Study design and setting

We conducted a quasi-experimental, community-based study with intervention and control health areas and cross-sectional household surveys before (baseline, July 2025) and after (endline, December 2025) a three-month intervention. The two surveys drew independent samples of caregivers from the same health areas. This study was reported in accordance with the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) statement [28]; The North West Region is one of the ten regions of Cameroon, with Bamenda as its capital, an estimated population of approximately 1.7 million, and seven administrative divisions. Its economy is largely agricultural, settlement is scattered across mountainous terrain, and health services have been disrupted by the conflict since 2016 [13]. Data were collected in the baseline survey in July 2025 and in the endline survey in December 2025.

2.2 Study areas and participants

Four of the seven divisions were selected by simple random sampling; three were assigned to the intervention arm and one to the control arm, and this allocation was not randomized. One health district was selected by ballot in each division, and two health areas by simple random sampling in each district. The intervention arm therefore comprised six health areas in the Batibo, Wum and Misaje health districts (Batibo urban, Misaje urban and Wum urban, classified as urban; Dumbu, Weh Azur and Widikum, classified as rural), and the control arm two health areas in the Bamenda health district (Azire, urban; Mendakwe, rural).

Participants were mothers or primary caregivers of children who had received MR1 and were targeted for MR2 at 15–24 months of age. Caregivers were eligible if they had lived in the community for at least one year and gave consent; caregivers of children who had not received MR1 were excluded. In each health area, a household list was compiled from the 2025 health area routine immunization microplan and the Neglected Tropical Diseases enumeration database with community health workers and community representatives , and households with eligible children were selected by systematic random sampling from a random start. If a household had more than one eligible child or caregiver, one was selected at random. Because household listing identified some children outside the target age band, all surveyed caregivers were retained for the analysis of knowledge, and the age distribution of the children is reported.

2.3 Sample size

The sample size was calculated for the study's primary outcome, MR2 uptake, using the formula for comparing two independent proportions [29]. Assuming MR2 uptake of 45% in the control arm and 55% in the intervention arm, a two-sided significance level of 5% and 80% power, 388 caregivers were required per arm, or 427 after a 10% allowance for non-response. In practice, enrolment was determined by the number of eligible caregiver–child pairs that could be reached in a conflict-affected setting, and all eligible caregivers identified in the sampled households were included. No design effect for clustering was applied.

2.4 Intervention

Twelve CICs, respected and literate residents of the intervention communities (women leaders, religious figures, local health volunteers and youth representatives), were trained by health personnel and the researcher on measles and the vaccination schedule, the importance of MR2, communication, responding to vaccine hesitancy, referral, and documentation. Over three months, the champions conducted door-to-door sensitization on measles and MR2, identified children who had missed MR2, referred caregivers to health facilities, supported fixed and outreach immunization sessions, and worked with traditional and religious leaders. Each champion kept a daily activity log, collected weekly by health facility staff, and the research team supervised activities through spot checks and review meetings. Routine immunization services continued unchanged in the control health areas.

2.5 Data collection and measurement of knowledge

Trained research assistants interviewed caregivers at home using a structured questionnaire adapted from the WHO vaccination coverage cluster survey manual [30] and the indicators of the WHO Strategic Advisory Group of Experts Working Group on Vaccine Hesitancy [31]. The questionnaire covered the socio-demographic characteristics, the child's immunization history from the vaccination card or, where no card was available, the caregiver's report, knowledge of measles and MR2, attitudes towards vaccination, and access to services. The same questionnaire and procedures were used at baseline and endline. The tools were reviewed by a panel of public health experts and pre-tested among 100 mother–child pairs in the Nkambe, Fundong, and Santa health districts, which were not part of the study; the multi-item knowledge, attitude, and perception sections had a Cronbach's alpha of 0.75. Supervisors checked completeness and consistency daily. Neither the research assistants nor the caregivers were blinded to the study arm.

Knowledge was measured using six items, each scored 1 for a correct response: having heard of measles; knowing that measles can cause serious illness or death; having heard of MR2; knowing that MR2 is administered at 15–24 months of age; providing a correct reason for the second dose (to prevent measles or to complete vaccination); and knowing that one dose of measles vaccine is insufficient. The score ranged from 0 to 6, and a score of 4 or more indicated adequate knowledge. Because the score combines general awareness with knowledge specific to MR2, each item is also reported separately.

2.6 Statistical analysis

Data were cleaned and analyzed using IBM SPSS Statistics version 27. The characteristics of the two arms were compared at each survey round using Pearson's chi-square test. Within each arm and setting, knowledge at endline was compared with knowledge at baseline using the chi-square test, or Fisher's exact test when expected cell counts were below five, and the knowledge score with the Mann–Whitney U test, because the two rounds were independent samples. Proportions are presented with Wilson 95% confidence intervals (CI) [32].

The intervention effect on each knowledge item and on adequate knowledge was estimated as the difference-in-differences (DiD): the change from baseline to endline in the intervention arm minus the change in the control arm, in percentage points, with a Wald 95% CI that treated caregivers as independent observations. The DiD for the mean knowledge score was estimated similarly. Because outcomes may be correlated within health areas, the DiD for adequate knowledge was re-estimated with standard errors that allowed clustering of caregivers within the eight health areas. To examine whether the effect differed by setting, DiD estimates were calculated separately for urban health areas (three intervention and one control) and rural health areas (three intervention, one control). Item-level and setting-specific estimates were computed from tabulated counts in Python 3 (SciPy and statsmodels).

To examine whether knowledge was associated with the study's primary outcome, binary logistic regression of MR2 receipt was fitted among children aged 15–24 months with known MR2 status in both rounds. The model included survey round, study arm, and their interaction, together with the variables associated with uptake at $P < 0.20$ in bivariate analysis: child sex and age group, caregiver sex, marital status, education, occupation, relationship to the child, length of residence, number of children under two years in the household, travel time to the nearest vaccinating facility, mode of transport, availability of a vaccination card, a history of missed vaccination appointments, having been reminded about MR2, and adequate knowledge. Multicollinearity was assessed using variance inflation factors. Statistical significance was set at $P < 0.05$ (two-sided).

3 RESULTS AND DISCUSSIONS

3.1 Characteristics of participants

At baseline, 913 caregivers were surveyed: 371 in the intervention arm (197 urban, 174 rural) and 542 in the control arm (229 urban, 313 rural). At endline, 666 caregivers were surveyed: 299 in the intervention arm (149 urban, 150 rural) and 367 in the control arm (211 urban, 156 rural). The arms differed in composition at both rounds (Table 1). Caregivers in the intervention arm were almost all women (94.9% at baseline) and mostly the child's mother (87.9%), and few had tertiary education (5.1%); in the control arm, 60.3% of caregivers were women, 43.7% were the child's mother, and 38.9% had tertiary education. The composition of the control arm also changed between rounds: the proportion of respondents who were the child's mother rose from 43.7% to 67.0%, and the proportion of children aged 15–24 months from 74.0% to 98.6%. In the intervention arm, 37.7% of children at baseline and 74.9% at endline were aged 15–24 months, because the urban intervention sample at baseline was markedly younger (mean age 9.8 months).

Table 1: Characteristics of children and caregivers by study arm and survey round

Characteristic	Baseline			Endline		
	Intervention (n = 371) n (%)	Control (n = 542) n (%)	P	Intervention (n = 299) n (%)	Control (n = 367) n (%)	P
Child						
Male sex	194 (52.3)	341 (62.9)	0.001	156 (52.2)	193 (52.6)	0.92
Aged 15–24 months	140 (37.7)	401 (74.0)	<0.001	224 (74.9)	362 (98.6)	<0.001
Caregiver						
Female	352 (94.9)	327 (60.3)	<0.001	284 (95.0)	298 (81.2)	<0.001
Child's mother	326 (87.9)	237 (43.7)	<0.001	267 (89.3)	246 (67.0)	<0.001
Caregiver age group[a]			<0.001			0.035
15–24 years	119 (32.1)	124 (22.9)		87 (29.1)	81 (22.1)	
25–34 years	167 (45.0)	325 (60.0)		166 (55.5)	208 (56.7)	
≥35 years	79 (21.3)	88 (16.2)		45 (15.1)	78 (21.3)	
Marital status			<0.001			0.13
Married	251 (67.7)	297 (54.8)		221 (73.9)	245 (66.8)	
Single	91 (24.5)	224 (41.3)		68 (22.7)	106 (28.9)	

Divorced or widowed	29 (7.8)	21 (3.9)		10 (3.3)	16 (4.4)	
Education[b]			<0.001			<0.001
Primary	152 (41.0)	89 (16.4)		126 (42.1)	65 (17.7)	
Secondary	149 (40.2)	204 (37.6)		111 (37.1)	141 (38.4)	
Tertiary	19 (5.1)	211 (38.9)		15 (5.0)	132 (36.0)	
Not recorded	51 (13.7)	38 (7.0)		47 (15.7)	29 (7.9)	
Occupation			<0.001			<0.001
Farmer	124 (33.4)	89 (16.4)		84 (28.1)	39 (10.6)	
Housewife	124 (33.4)	52 (9.6)		125 (41.8)	39 (10.6)	
Business	68 (18.3)	184 (33.9)		54 (18.1)	129 (35.1)	
Teaching	14 (3.8)	88 (16.2)		16 (5.4)	39 (10.6)	
Other	41 (11.1)	129 (23.8)		20 (6.7)	121 (33.0)	
Religion			<0.001			<0.001
Christian	302 (81.4)	278 (51.3)		231 (77.3)	248 (67.6)	
Muslim	63 (17.0)	86 (15.9)		67 (22.4)	57 (15.5)	
Other	6 (1.6)	178 (32.8)		1 (0.3)	62 (16.9)	
Lived in community >5 years	201 (54.2)	115 (21.2)	<0.001[c]	202 (67.6)	106 (28.9)	<0.001[c]

P values are from Pearson's chi-square test comparing the arms within each round. [a]Caregiver age was not recorded for six intervention and five control caregivers at baseline and one intervention caregiver at endline. [b]Test excludes "not recorded." [c]Test across three categories of length of residence (<1, 1–5, and >5 years).

3.2 Caregiver knowledge at baseline

At baseline, awareness was high: 95.2% of caregivers had heard of measles, 88.6% knew that it can cause serious illness or death, and 84.3% had heard of MR2 (Table 2). Knowledge specific to the second dose was weaker. Seven in ten caregivers (70.6%; 95% CI 67.6–73.5) knew that MR2 is given at 15–24 months, and almost half (47.9%; 95% CI 44.6–51.1) believed that one dose of measles vaccine is sufficient. This belief was held by 12.9% of intervention caregivers and 71.8% of control caregivers. Overall, 85.9% (95% CI 83.5–88.0) had adequate knowledge, ranging from 74.7% in the rural intervention group to 90.4% in the rural control group; the rural intervention group was also the least likely to have heard of measles (81.0%) or MR2 (63.8%).

3.3 Change in knowledge after the intervention

In the intervention arm, the proportion of caregivers who had heard of MR2 rose from 76.8% to 92.0%, and the proportion who knew that MR2 was due at 15–24 months from 67.1% to 82.3% (both $P < 0.001$), whereas neither changed significantly in the control arm (Table 2). Adequate knowledge rose from 82.7% to 88.6% in the intervention arm ($P = 0.032$) and fell from 88.0% to 82.6% in the control arm ($P = 0.021$), a DiD of 11.3 percentage points (95% CI 4.2–18.4; $P = 0.002$). The mean knowledge score rose from 4.82 to 5.26 in the intervention arm ($P < 0.001$) and did not change in the control arm (4.64 to 4.68; $P = 0.30$), a DiD of 0.40 points (95% CI 0.15–0.65). When standard errors allowed for clustering within the eight health areas, the DiD for adequate knowledge was no longer statistically significant ($P = 0.098$).

The overall estimates combined items that moved in different directions. The largest effects were for having heard of MR2 (DiD 17.2 points; 95% CI 10.4–24.0) and knowing when MR2 is due (19.0; 10.2–27.8). The DiD of 15.4 points for knowing that measles can be serious arose from a fall in the control arm (93.9% to 82.6%) rather than a gain in the intervention arm (80.9% to 84.9%; $P = 0.17$). The belief that one dose is enough did not change in the intervention arm, where 74.9% knew at endline that one dose is not enough (76.0% at baseline), whereas this knowledge rose in the control arm from 18.5% to 31.6%, giving a DiD of −14.3 points (95% CI −23.0 to −5.5) that favoured the control arm.

Table 2: Caregiver knowledge of measles and MR2 before and after the intervention, by study arm

Knowledge item	Intervention			Control			DiD, percentage points (95% CI)	P
	Baseline (n = 371) n (%)	Endline (n = 299) n (%)	P	Baseline (n = 542) n (%)	Endline (n = 367) n (%)	P		
Has heard of measles	333 (89.8)	280 (93.6)	0.073	536 (98.9)	365 (99.5)	0.49[a]	3.3 (−1.0 to 7.6)	0.13
Knows measles can cause serious illness or death	300 (80.9)	254 (84.9)	0.17	509 (93.9)	303 (82.6)	<0.001	15.4 (8.3 to 22.6)	<0.001
Has heard of MR2	285 (76.8)	275 (92.0)	<0.001	485 (89.5)	321 (87.5)	0.35	17.2 (10.4 to 24.0)	<0.001
Knows MR2 is given at 15–24 months	249 (67.1)	246 (82.3)	<0.001	396 (73.1)	254 (69.2)	0.21	19.0 (10.2 to 27.8)	<0.001
Gives a correct reason for the second dose	338 (91.1)	294 (98.3)	<0.001	490 (90.4)	357 (97.3)	<0.001	0.4 (−4.1 to 4.8)	0.88
Knows one dose of measles vaccine is not enough	282 (76.0)	224 (74.9)	0.74	100 (18.5)	116 (31.6)	<0.001	−14.3 (−23.0 to −5.5)	0.001
Adequate knowledge (score ≥4)	307 (82.7)	265 (88.6)	0.032	477 (88.0)	303 (82.6)	0.021	11.3 (4.2 to 18.4)[b]	0.002
Knowledge score (0–6), mean (SD)	4.82 (1.57)	5.26 (1.23)	<0.001[c]	4.64 (0.98)	4.68 (1.10)	0.30[c]	0.40 (0.15 to 0.65)[d]	0.002

Within-arm P values are from the chi-square test, unless indicated. DiD, difference-in-differences: the change in the intervention arm minus the change in the control arm, with a Wald 95% confidence interval treating caregivers as independent. [a]Fisher's exact test. [b]P = 0.098 with standard errors clustered by health area (eight clusters). [c]Mann–Whitney U test. [d]Difference in mean change in score points. MR2, second dose of measles-containing vaccine; SD, standard deviation.

3.4 Differences between urban and rural health areas

The intervention effect was confined to rural health areas (Table 3; Fig. 1). In the rural intervention group, adequate knowledge rose from 74.7% to 92.7% (P < 0.001), the proportion who had heard of MR2 from 63.8% to 98.0%, and the proportion who knew when MR2 is due from 64.9% to 88.0%, while adequate knowledge in the rural control group fell from 90.4% to 85.3% (P = 0.096). The rural DiD for adequate knowledge was 23.1 percentage points (95% CI 13.1–33.1). In urban health areas, adequate knowledge fell in both the intervention (89.8% to 84.6%) and the control groups (84.7% to 80.6%), and the DiD was −1.1 percentage points (95% CI −11.2 to 8.9). Knowledge that one dose is not enough fell in the urban intervention group (83.8% to 73.8%; P = 0.024), and the large negative DiD for this item came from the rural control group, where it rose from 14.7% to 54.5% (Fig. 2).

Table 3: Change in caregiver knowledge in urban and rural health areas

Outcome and setting	Intervention		Control		DiD (95% CI)	P
	Baseline	Endline	Baseline	Endline		
Adequate knowledge (score ≥4), n (%)						
Urban	177 (89.8)	126 (84.6)	194 (84.7)	170 (80.6)	−1.1 (−11.2 to 8.9)	0.83
Rural	130 (74.7)	139 (92.7)	283 (90.4)	133 (85.3)	23.1 (13.1 to 33.1)	<0.001
Knowledge score (0–6), mean (SD)						
Urban	5.22 (1.22)	5.12 (1.36)	4.60 (1.09)	4.48 (1.00)	0.02 (−0.32 to 0.36)[a]	0.91
Rural	4.36 (1.79)	5.40 (1.07)	4.67 (0.89)	4.94 (1.17)	0.77 (0.39 to 1.15)[a]	<0.001
Has heard of MR2, n (%)						
Urban	174 (88.3)	128 (85.9)	197 (86.0)	172 (81.5)	2.1 (−7.9 to 12.0)	0.68
Rural	111 (63.8)	147 (98.0)	288 (92.0)	149 (95.5)	30.7 (22.0 to 39.4)	<0.001
Knows MR2 is given at 15–24 months, n (%)						
Urban	136 (69.0)	114 (76.5)	162 (70.7)	142 (67.3)	10.9 (−1.8 to 23.7)	0.094
Rural	113 (64.9)	132 (88.0)	234 (74.8)	112 (71.8)	26.0 (13.8 to 38.3)	<0.001
Knows one dose is not enough, n (%)						
Urban	165 (83.8)	110 (73.8)	54 (23.6)	31 (14.7)	−1.0 (−12.4 to 10.3)	0.86
Rural	117 (67.2)	114 (76.0)	46 (14.7)	85 (54.5)	−31.0 (−44.1 to −17.9)	<0.001

Group sizes, baseline, and endline: urban intervention 197 and 149; rural intervention 174 and 150; urban control 229 and 211; and rural control 313 and 156. DiD, difference-in-differences in percentage points with Wald 95% confidence interval. [a]Difference in mean change in score points. MR2, second dose of measles-containing vaccine; SD, standard deviation.

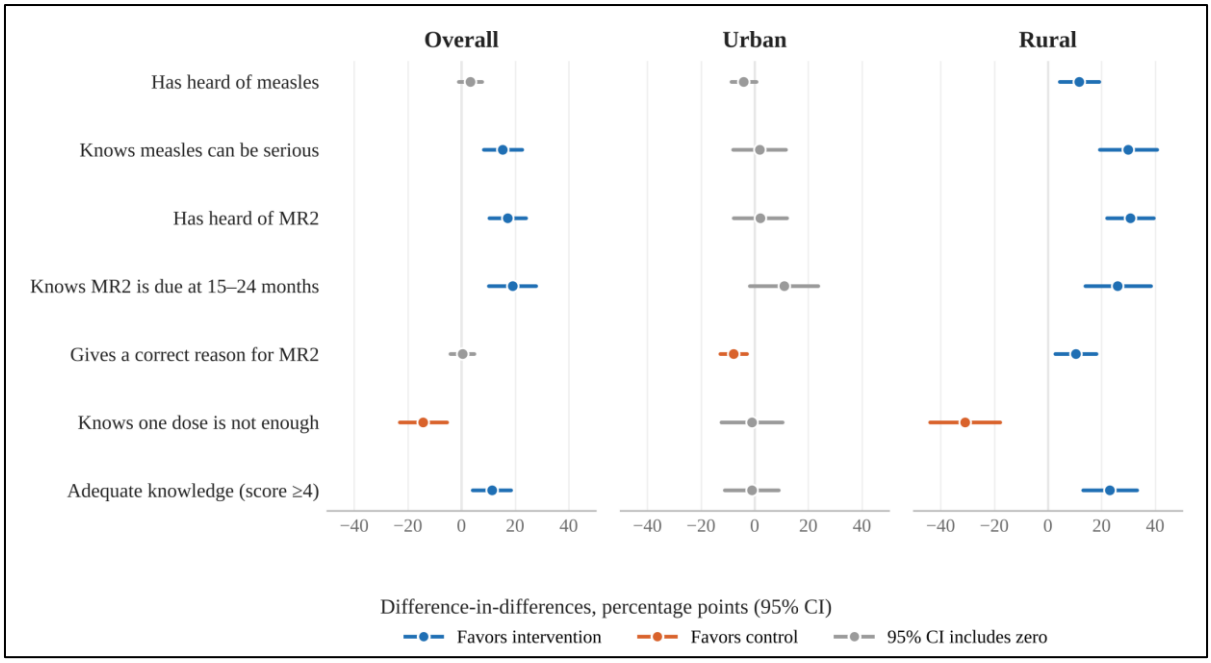


Figure 1: Difference-in-differences estimates for each knowledge item, overall and by setting. Points show the change in the intervention arm minus the change in the control arm, in percentage points, with Wald 95% confidence intervals treating caregivers as independent. Blue estimates favor the intervention arm, orange estimates favor the control arm, and grey intervals include zero

3.5 Knowledge and MR2 uptake

Among 1,093 children aged 15–24 months with known MR2 status in the two rounds combined, MR2 was received by 48.9% (473/968) of children whose caregivers had adequate knowledge and by 31.2% (39/125) of those whose caregivers did not. After adjustment for survey round, study arm, their interaction, and other factors in the model, adequate caregiver knowledge was independently associated with MR2 uptake (adjusted odds ratio [aOR] 2.76; 95% CI 1.56–4.87; $P < 0.001$). Having been reminded about MR2 (aOR 2.40; 95% CI 1.42–4.07) was also associated with higher uptake, and no variance inflation factor reached 5.

4 DISCUSSION

In this quasi-experimental study in a conflict-affected region of Cameroon, caregivers were broadly aware of measles and MR2 before the intervention, but many did not know when MR2 was due, and almost half believed that one dose of measles vaccine was sufficient. After three months of community immunization champion activity, knowledge specific to MR2 improved in the intervention arm and not in the control arm. The improvement was confined to rural health areas, where knowledge was lowest, and was absent in urban health areas. The intervention did not reduce the belief that one dose is sufficient, and the overall effect was not statistically significant once clustering within health areas was taken into account.

The gains were concentrated in the two items that the champions' household messages addressed most directly: having heard of MR2 and knowing when it is due. This is consistent with community-based interventions that improve caregiver knowledge and immunization uptake in Uganda [24, 25], with systematic reviews showing that lay health workers and health education improve childhood immunization [17, 20], and with the educational role described for vaccine champions in Fiji [23]. That the gain occurred in the rural intervention group, where only 63.8% of caregivers had heard of MR2 at baseline, supports the view that community-based workers extend programmes to populations that facility-based services reach least [21, 22]. The overall effect on adequate knowledge was modest; however. Adequate knowledge was already high at baseline in most groups, which left little room for improvement, and the composite score included awareness items that almost every caregiver answered correctly; therefore, a caregiver could be classified as having adequate knowledge while still being wrong about the second dose. The item-level results were therefore a better guide to what changed than the composite.

The lack of any effect in urban health areas needs explanation. The urban intervention group started with high knowledge, but its knowledge did not rise on any MR2-specific item and fell on the item about whether one dose is enough. In the wider evaluation, the proportion of caregivers reminded about MR2 rose in rural but not in urban intervention communities, which suggests that the champions reached fewer urban households. Urban caregivers are more often away from home during the day and receive vaccination information from many competing sources [33], and door-to-door strategies designed for close-knit rural communities may need adapting, for example through market, workplace, or telephone contact, before they are extended to towns.

The belief that one dose of measles vaccine is sufficient was the most important misconception identified. It was held by about one in four intervention caregivers at endline and by more than two-thirds of control caregivers at baseline, although the control communities were better educated. Education is a consistent predictor of immunization in low- and middle-income countries [34], but formal schooling does not guarantee knowledge of a particular vaccination schedule [35]. Missed opportunities to explain the schedule when the first dose is given [36] may account for part of the misconception, since a caregiver who is not told at the MR1 visit that another dose will follow has no reason to return. In terms of the Health Belief Model, these caregivers already accepted that measles is serious, but the perceived benefit of a second dose had not been established [12]. Lack of awareness of the second dose has been identified as a barrier to MR2 uptake elsewhere in Africa [9, 10], and in this study, adequate knowledge was independently associated with MR2 uptake. Champion and health-worker messages should therefore state plainly that a second dose is required and when it is due, rather than promoting vaccination in general terms.

Several features of the control arm call for caution in interpreting the DiD estimates. Knowledge that measles can be serious fell from 96.2% to 78.8% in the rural control group over three months, and adequate knowledge fell in both control groups. Real losses of knowledge on this scale are unlikely in such a short period. Because the baseline and endline surveys were independent samples, these changes probably reflect differences in who was interviewed: in the control arm, the proportion of respondents who were the child's mother rose from 43.7% to 67.0% between rounds. About half of the overall DiD for adequate knowledge arose from this decline in the control arm rather than from a gain in the intervention arm. Conversely, knowledge that one dose is not enough rose sharply in the rural control group without any champion activity, which indicates that caregivers there received information from other sources during the study period. Neither change can be attributed to the intervention, and both show that the comparison between arms rests on a single control area per setting.

The study has strengths. It measured knowledge in intervention and control communities before and after the intervention in a conflict-affected setting from which evidence is scarce, used the same instrument and procedures in both rounds, reported each knowledge item separately as well as the composite score, examined urban and rural settings separately, and linked caregiver knowledge to the study's primary outcome, MR2 uptake. It also has limitations. First, divisions were not allocated at random, and the arms differed markedly in caregiver sex, education, relationship to the child, and religion; the DiD approach removes differences that are constant over time but not differences in the composition of independent samples. Second, the comparison rested on eight health areas, only two of which were controls. With so few clusters, conventional cluster-robust standard errors are themselves unreliable [37, 38], and the effect could not be separated with confidence from differences between health areas. Third, the baseline and endline surveys interviewed different caregivers, so the changes described communities rather than individuals. Fourth, the knowledge score was short, dominated by general awareness, and dichotomized at a low threshold, and knowledge was self-reported; caregivers who had been visited by champions may have been more likely to give the expected answers. Fifth, a substantial proportion of children at baseline, particularly in the urban intervention group, were younger than the 15–24-month target age, and the sample in the intervention arm was below the planned 427. Finally, the intervention lasted three months, and the study could not show whether the gains in knowledge were sustained or describe in detail how many households each champion reached.

These findings have practical implications. Community immunization champions appear able to raise knowledge of MR2 in rural communities with the least knowledge, which is where the gap between the first and second doses is likely to be greatest. Their messages, and those of health workers at the MR1 visit, should explicitly address the single-dose misconception, and the approach should be adapted before it is extended to urban areas. Future evaluations should allocate more health areas to each arm, preferably at random, follow the same caregivers over time, measure MR2-specific knowledge with a validated instrument, and record the reach and intensity of champion activity.

5 CONCLUSIONS

In the North West Region of Cameroon, caregivers were aware of measles and MR2, but many did not know when MR2 was due or that a second dose was needed. A three-month community immunization champion intervention was associated with improved MR2-specific knowledge in rural communities, where knowledge was weakest, but not in urban communities, and it did not correct the belief that one dose of measles vaccine is sufficient. Because caregiver knowledge was associated with MR2 uptake, champion and health-worker messages should state explicitly that a second dose is required and when it is due. The size of the effect remains uncertain because the comparison rested on few health areas, and larger evaluations are needed before the strategy is scaled up.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare no competing interests.

Statement of ethical approval

The study was approved by the Regional Ethics Committee for Human Health Research, North West Region, Cameroon (reference No. 2025/06/93/CERSH-NW), and was conducted in accordance with the Declaration of Helsinki. Administrative authorization was obtained from the North West Regional Delegation of Public Health and the district health services of the participating health districts.

Statement of informed consent

Verbal informed consent, approved by the ethics committee, was obtained from all participants after the purpose, procedures, risks and benefits of the study and their right to decline or withdraw had been explained. Data were recorded without names and kept confidential.

Authors' contributions, data availability and use of AI tools

EEA conceived and designed the study, coordinated the intervention and data collection, analyzed and interpreted the data, and drafted the manuscript. CTW and BE supervised the study; OV,AIGB, CC,BE,CTW, contributed to its design and to the interpretation of the data, and critically revised the manuscript. All authors approved the final manuscript. The

datasets are available from the corresponding author on reasonable request. No artificial intelligence tools were used in the development, preparation or writing of this manuscript

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ADDITIONAL FILE 1. TREND STATEMENT CHECKLIST

Article 1 of 2 from the study: caregiver KNOWLEDGE of measles and MR2

Manuscript: Community immunization champions and caregiver knowledge of the second dose of measles-containing vaccine in the conflict-affected North West Region of Cameroon: a quasi-experimental study

Checklist: Transparent Reporting of Evaluations with Nonrandomized Designs (TREND), Des Jarlais DC, Lyles C, Crepaz N; TREND Group. Am J Public Health. 2004;94(3):361–6. Page numbers refer to the submitted manuscript file.

Section/topic	Item no.	Descriptor	Reported in this manuscript	Page
Title and abstract	1	Information on how units were allocated to interventions; structured abstract recommended; information on target population or study sample	Title ("a quasi-experimental study"); structured Abstract with Background, Methods, Results, Conclusions and Trial registration; study sample of caregivers in six intervention and two control health areas	1–2
Introduction: background	2	Scientific background and explanation of rationale; theories used in designing behavioural interventions	Background: measles and MR2 coverage gap; caregiver knowledge of the second dose as a determinant of MR2 uptake; Health Belief Model (perceived benefit of a second dose); community-based approaches	4–5
Methods: participants	3	Eligibility criteria for participants; method of recruitment; recruitment setting; settings and locations where data were collected	Methods: Participants and sampling (eligibility, household listing, systematic sampling); Study design and setting; Selection of study areas	5–6
Methods: interventions	4	Details of the interventions intended for each study condition and how and when they were actually administered (content, delivery method, unit of delivery, deliverer, setting, exposure quantity and duration, time span, activities to increase compliance)	Methods: Intervention (champion selection, training content, door-to-door sensitization on measles and MR2, defaulter identification, referral, three-month duration, weekly supervision; control areas received routine services)	7
Methods: objectives	5	Specific objectives and hypotheses	Background, final paragraph: objective 1 – caregiver knowledge of measles and MR2 before and after the intervention; urban–rural comparison; association of knowledge with MR2 uptake	5
Methods: outcomes	6	Clearly defined primary and secondary outcome measures; methods used to collect data and to enhance their quality; information on validated instruments	Methods: Data collection and measurement of knowledge (six-item knowledge score, 0–6; adequate knowledge ≥4; each item reported separately; instrument adapted from WHO tools, expert review, pre-test, Cronbach's alpha 0.75)	8
Methods: sample size	7	How sample size was determined	Methods: Sample size	7

Methods: assignment method	8	Unit of assignment; method used to assign units to study conditions; inclusion of aspects employed to help minimize potential bias induced by non-randomization	Methods: Selection of study areas (divisions allocated to arms, not randomized); Statistical analysis (difference-in-differences, setting-specific estimates)	6, 8–9
Methods: blinding	9	Whether participants, those administering the interventions and those assessing the outcomes were blinded to study condition assignment	Methods: Data collection and measurement of knowledge (research assistants and caregivers not blinded)	8
Methods: unit of analysis	10	Description of the smallest unit analysed to assess intervention effects; if different from the unit of assignment, the analytical method used to account for this	Methods: Statistical analysis (caregiver as unit of analysis; difference-in-differences for adequate knowledge re-estimated with standard errors clustered by health area)	8–9
Methods: statistical methods	11	Statistical methods used to compare study groups for primary outcomes, including complex methods for correlated data; methods for additional analyses; methods of imputing missing data; statistical software	Methods: Statistical analysis (chi-square, Fisher's exact and Mann–Whitney U tests; difference-in-differences with Wald 95% CIs; Wilson CIs; logistic regression of MR2 receipt; SPSS 27 and Python)	8–9
Results: participant flow	12	Flow of participants through each stage of the study	Results: Characteristics of participants (caregivers surveyed per arm, setting and round; independent cross-sectional samples)	10
Results: recruitment	13	Dates defining the periods of recruitment and follow-up	Methods: Study design and setting (baseline and endline survey dates)	5
Results: baseline data	14	Baseline demographic and clinical characteristics of participants in each study condition	Results: Characteristics of participants; Table 1	10–11
Results: baseline equivalence	15	Data on study group equivalence at baseline and statistical methods used to control for baseline differences	Table 1 (arm comparison at each round); Results: Caregiver knowledge at baseline; Discussion (baseline imbalance and composition of independent samples)	11, 17
Results: numbers analysed	16	Number of participants included in each analysis for each study condition	Tables 2 and 3 (denominators for each arm, setting and round); Results: Knowledge and MR2 uptake (n = 1,093 children)	13–14
Results: outcomes and estimation	17	For each primary and secondary outcome, a summary of results for each study condition, and the estimated effect size and a confidence interval	Results: Change in knowledge after the intervention; Table 2 (adequate knowledge DiD 11.3 percentage points, 95% CI 4.2–18.4; item-level DiD); Fig. 2	12–13
Results: ancillary analyses	18	Summary of other analyses performed, including subgroup or restricted analyses, indicating which are pre-specified or exploratory	Results: Differences between urban and rural health areas (Table 3, Fig. 1); Knowledge and MR2 uptake (adjusted odds ratio 2.76)	13–14
Results: adverse events	19	Summary of all important adverse events or unintended effects in each study condition	Not assessed (educational, non-clinical intervention)	–
Discussion: interpretation	20	Interpretation of the results, taking into account study hypotheses, sources of potential bias, imprecision of measures,	Discussion (MR2-specific knowledge gains, ceiling effect of the composite, single-dose misconception, control-	14–17

		multiplicative analyses and other limitations	arm changes, few clusters, limitations)	
Discussion: generalizability	21	Generalizability (external validity) of the findings, taking into account the study population, the characteristics of the intervention, length of follow-up and other contextual issues	Discussion (urban–rural differences, conflict-affected setting, three-month duration, limitations)	15, 17
Discussion: overall evidence	22	General interpretation of the results in the context of current evidence and current theory	Discussion; Conclusions	14–18