Research Square

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Dental caries burden and unmet restorative need across three Fijian sites: a cross-sectional study from a 2025–2026 Taiwanese humanitarian dental mission

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Abstract

Background.

Pacific Island populations carry a disproportionate burden of dental disease, but contemporary epidemiological data on adult dental caries from Fiji remain sparse, particularly outside the divisional capitals. We described the dental caries burden, the unmet restorative treatment gap, and selected cardiometabolic findings encountered during a Taiwanese humanitarian dental mission to three Fijian communities.

Methods.

A cross-sectional dataset of 226 individuals examined across two mission waves (October 2025 and May 2026) at Nadi Hospital, Sarada Medical Centre, and the rural village of Nawaka was analysed. Dental caries was scored using WHO criteria as Decayed, Missing and Filled Teeth (DMFT). Total DMFT was modelled with negative binomial regression and robust standard errors. Secondary outcomes — high caries burden (DMFT ≥ 4), the proportion of decayed teeth among caries-affected teeth (DT/DMFT), and the care index (FT/DMFT) — were modelled with logistic and fractional logit regression. Hypertension (JNC8 criteria) and obesity (body mass index, BMI, ≥ 30 kg/m²) were examined in the Wave 2 subset, where blood pressure was measured.

Results.

Median DMFT was 7.0 (interquartile range 4–11) and 71.6% of participants had a high caries burden. After adjustment for age, sex, toothbrushing frequency, tobacco use and alcohol use, attendees at Sarada Medical Centre showed a lower DMFT than walk-in attendees at Nadi Hospital (adjusted IRR 0.66, 95% CI 0.56–0.79; $p < 0.001$); DMFT at Nawaka did not differ from Nadi (IRR 1.04, 95% CI 0.81–1.34). Each one standard deviation increase in age was associated with a 25% higher DMFT (IRR 1.25, 95% CI 1.13–1.39). The proportion of untreated decay among caries-affected teeth was lower at both Sarada (OR 0.50, 95% CI 0.33–0.75) and Nawaka (OR 0.30, 95% CI 0.18–0.49) than at Nadi, but the care index (FT/DMFT) was markedly lower at Nawaka (OR 0.10, 95% CI 0.03–0.36), so the apparent reduction in untreated decay at the most remote site reflected tooth loss rather than restorative care. Overall obesity prevalence (n = 205 with BMI) was 42.0%; among Wave 2 participants with valid blood pressure, 42.0% met JNC8 criteria for hypertension.

Conclusions.

Dental caries burden across these three Fijian communities is high, and there is a clear gradient of restorative care between hospital-based and remote outreach settings. The co-occurrence of obesity and hypertension supports an integrated approach to dental and broader noncommunicable disease care in future outreach missions to the region.

Clinical trial number:

not applicable.

Background

Dental caries remains the most prevalent noncommunicable disease worldwide. The Global Burden of Disease 2017 study estimated that 2.3 billion people lived with untreated caries in their permanent teeth, with much of that burden falling on populations in low- and middle-income countries [1]. The 2019 Lancet Series on oral health called for closer integration of dental care into primary care platforms, especially in settings where dentistry has historically been treatment-led, isolated from broader health systems, and reached only a minority of the population [2, 3].

The Pacific Island region illustrates these structural challenges. A recent scoping review of Pacific oral health epidemiology described high prevalences of dental caries and tooth loss across Pacific peoples, persistent ethnic disparities, and substantial unmet treatment need [4]. Fiji, with a population of around 900,000 distributed across more than one hundred inhabited islands, has limited dental workforce capacity, no national water fluoridation, and only intermittent epidemiological surveillance of adult oral health outside school-based programmes [5, 6]. A multicentre study of hospital-managed odontogenic infections across three divisional hospitals in Fiji recently reported that dental caries was the underlying cause in roughly nine of every ten cases [7], a finding that underlines the clinical consequences of delayed restorative care. The bulk of existing Fijian oral health data comes from school surveys, hospital-based admissions and institutionalised elderly residents [8, 9], rather than from the community-dwelling adult population that turns up at outreach activities.

Dental caries shares major upstream risk factors with the leading noncommunicable diseases — free sugars, tobacco, alcohol and poor oral hygiene — and the common risk factor approach to oral health promotion has long argued for joint rather than parallel prevention pathways [10]. In Pacific Island nations, where obesity, diabetes and hypertension are among the most prevalent in the world, there is a clear case for combining dental outreach with broader noncommunicable disease screening. A community-level survey from western Fiji previously reported that about one in three adults were obese and that more than one in three had hypertension, with both i-Taukei and Indo-Fijian populations carrying high levels of cardiovascular risk [11]. Despite this overlap, dental missions and noncommunicable disease screening campaigns are often planned in isolation.

MacKay Memorial Hospital (Taipei, Taiwan) has operated a hospital-based international humanitarian medical mission programme for more than a decade, with periodic deployments to Pacific Island nations including Fiji. In late 2025 and again in mid-2026, the dental team carried out two mission waves to the western division of Viti Levu, working in partnership with Nadi Hospital and conducting outreach at a community medical centre (Sarada Medical Centre) and a village clinic (Nawaka). The mission generated a structured clinical dataset that combined WHO-standardised dental caries assessment with brief lifestyle measurements and, during the second wave, anthropometric and blood pressure measurements.

The present analysis had three objectives. The first was to describe the dental caries burden — in terms of DMFT, untreated decay, and restorative care — across the three communities visited, using a common WHO scoring protocol. The second was to examine whether site of examination remained associated with caries severity after adjustment for individual-level risk factors; our working hypothesis was that any residual site effects would mainly reflect differences in access to restorative care rather than differences in caries biology. In the Wave 2 subset where blood pressure was measured, we also explored the co-occurrence of hypertension and obesity with dental disease, with a view to informing the design of integrated outreach activities.

Methods

Study design and setting

This was a cross-sectional analysis of two consecutive waves of the MacKay Memorial Hospital International Dental Outreach Programme to Fiji. Wave 1 was conducted in October 2025 and Wave 2 in May 2026. Three sites were visited during the combined mission period: (i) Nadi Hospital, a public divisional hospital serving the western division of Viti Levu, which was visited during Wave 1 only; (ii) Sarada Medical Centre, a community medical centre in the greater Nadi area, visited during Wave 2; and (iii) Nawaka, a rural village reached through Nadi Hospital's outreach team, also visited during Wave 2. The Fijian dental and clinical staff at Nadi Hospital and Sarada Medical Centre, together with the Nadi Hospital outreach team to Nawaka, provided on-site coordination, triage, interpretation, and clinical facilitation throughout the mission.

Participants

Eligible participants were individuals of any age who presented to the mission clinic at any of the three sites during the operational period and who consented to a dental examination. Recruitment was based on convenience: at Nadi Hospital and Sarada Medical Centre, participants were walk-in attendees who learned of the mission through local notices and word of mouth; at Nawaka, the outreach team held clinics within the village with prior community announcement. No upper or lower age limits were applied. Pregnant women and individuals with acute infection were examined for caries but were not asked to undergo blood pressure measurement when this was clinically inappropriate. Written informed consent was obtained from each participant. For participants below 18 years of age, written informed consent was obtained from a parent or legal guardian and assent was sought from the child.

Dental examination and caries scoring

Dental examination was carried out under portable LED illumination using a plain dental mirror and a CPI ball-end probe, in accordance with the World Health Organization Oral Health Surveys: Basic Methods, fifth edition. Decayed, missing and filled tooth scores were recorded at the tooth level for the full

permanent dentition. DMFT was the sum of decayed (D), missing-due-to-caries (M), and filled (F) teeth. All dental examinations and recording were performed by a single qualified examiner (ETY), a board-certified dentist from MacKay Memorial Hospital with prior experience in standardised caries scoring during earlier mission cycles. The same examiner scored every participant across both Wave 1 and Wave 2, removing inter-examiner variability as a source of measurement error. Intra-examiner calibration was carried out at MacKay Memorial Hospital before each mission wave on ten non-mission patients drawn from the routine dental outpatient clinic. Each patient was scored twice by the examiner, with the second scoring performed at least sixty minutes after the first and blinded to the original record. Intra-examiner agreement at the tooth level, expressed as Cohen's kappa, was 0.92 before Wave 1 and 0.94 before Wave 2, indicating near-perfect agreement and consistent with published reliability standards for WHO Basic Methods caries scoring. Third molars were included if erupted and clinically visible; partially erupted third molars were recorded as sound.

Anthropometric, blood pressure and questionnaire variables

Self-reported variables collected at all sites included sex, age, toothbrushing frequency (less than once per day, once per day, or at least twice per day), tobacco use (any current daily or non-daily smoking), and alcohol use (any consumption in the previous month). Height was measured to the nearest 0.5 cm with a portable stadiometer and weight to the nearest 0.1 kg with a calibrated digital scale; BMI was computed as weight in kilograms divided by height in metres squared. BMI was available at all three sites. Blood pressure measurement was added to the mission protocol from Wave 2 onwards in collaboration with the family medicine team, and was therefore available at Sarada Medical Centre and Nawaka but not at Nadi Hospital. Blood pressure was measured twice in the seated position after at least five minutes of rest using an automated upper-arm oscillometric device, and the mean of the two readings was used.

Outcomes

The primary outcome was total DMFT. Secondary outcomes were: (i) a high caries burden, defined a priori as DMFT ≥ 4, a threshold approximating the upper tercile of DMFT in adult community samples from the region [4]; (ii) the proportion of decayed teeth among caries-affected teeth (DT/DMFT) among participants with DMFT ≥ 1, used as an indicator of the unmet treatment fraction; and (iii) the care index (FT/DMFT) among the same subset, used as an indicator of restorative care received. In the Wave 2 subset with blood pressure data, hypertension was defined according to the 2014 JNC8 panel report as systolic blood pressure ≥ 140 mmHg, or diastolic blood pressure ≥ 90 mmHg, or current use of antihypertensive medication [12]. Obesity was defined as BMI ≥ 30 kg/m².

Statistical analysis

Categorical variables were summarised as counts and percentages, and continuous variables as medians with quartiles. Across-site comparisons used Kruskal–Wallis tests for continuous variables and

Pearson chi-square tests for categorical variables. The primary outcome DMFT was modelled by negative binomial regression with robust (sandwich) standard errors, which provides valid inference for an overdispersed count outcome with a heavy right tail and avoids the bias of treating DMFT as a continuous normal variable [13, 14]. The reference category for site was Nadi Hospital. Covariates were sex, standardised age (z-score), toothbrushing frequency (three categories), tobacco use and alcohol use. Effect estimates are presented as incidence rate ratios (IRR) with 95% confidence intervals.

The binary outcome of high caries burden was modelled by logistic regression with the same adjustment set, with results expressed as odds ratios (OR) with 95% CI. The proportion outcomes (untreated proportion and care index) were modelled by generalised linear models with a binomial family, logit link, and robust standard errors, restricted to participants with DMFT ≥ 1, since these proportions are undefined when DMFT = 0. Hypertension and obesity were modelled by logistic regression. Both logistic models were restricted to Wave 2 participants in order to share a common analytic frame with the blood pressure outcome; the Nadi reference category therefore drops out of these two models, and the Sarada/Nawaka contrast is reported. Toothbrushing frequency was omitted from the cardiometabolic models because of small-cell instability in the Wave 2 subset.

Two sensitivity analyses were pre-specified. First, the primary DMFT model was refitted restricted to adult participants (age ≥ 18 years) to confirm that the site effects were not driven by the small paediatric subgroup. Second, alternative count specifications — zero-inflated negative binomial and hurdle regression — were fitted to confirm that the negative binomial conclusions were not specification-driven (Supplementary Tables S1 and S2). An exploratory model incorporating a site-by-age product term was used to inspect whether the site effect varied across the age range. All analyses were conducted in Stata 19 (StataCorp, College Station, TX). Two-sided p-values < 0.05 were considered statistically significant. No imputation for missing data was performed; one participant with a missing DMFT score was excluded from the primary regression. A large language model (Claude, Anthropic) was used by the authors during manuscript preparation to assist with language editing and table formatting; the authors retained full responsibility for the study design, data analysis, interpretation of findings, and content of the final manuscript.

Ethics

The study protocol was reviewed and approved by the Institutional Review Board of MacKay Memorial Hospital, Taipei, Taiwan (approval number 25MMHIS307e), with a three-year approval period. Nadi Hospital, our local partner institution, does not maintain a separate institutional review board. All clinical activities were therefore carried out under the IRB approval issued in Taiwan, and with the full operational cooperation of the dental and clinical staff at Nadi Hospital and Sarada Medical Centre, and of the outreach team dispatched by Nadi Hospital to Nawaka. The mission followed the ethical principles of the Declaration of Helsinki.

Results

Sample characteristics

In total, 226 individuals were examined across the two mission waves: 55 at Nadi Hospital, 134 at Sarada Medical Centre, and 37 at Nawaka. The overall median age was 44 years (IQR 36–56), with Nadi attendees somewhat younger (median 40 years) than those at Sarada (46 years) and Nawaka (45 years; Kruskal–Wallis p = 0.016). The sample was 53.5% female. Eight participants (3.5%) were below 18 years of age and 40 (17.7%) were aged 60 years or older. Reported toothbrushing frequency differed across sites: brushing less than once per day was reported by 16.4% at Nadi, 31.3% at Sarada, and 29.7% at Nawaka, while brushing at least twice per day was uncommon at Nadi and Sarada (10.9% and 1.5%, respectively) but more common at Nawaka (32.4%; chi-square p < 0.001). Tobacco use was reported by 23.9% of the sample overall, and alcohol use by 40.3%. Full descriptive characteristics are shown in Table 1.

Table 1
Participant characteristics by mission site, Fiji 2025–2026 (N = 226).

Variable	Nadi	Sarada	Nawaka	Total	p-value
	(n = 55)	*(n = 134)*	*(n = 37)*	*(n = 226)*	
Continuous variables, median (p25, p75)					
Age (years)	40 (30, 52)	46 (39, 57)	45 (36, 56)	44 (36, 56)	0.016
DMFT	9.5 (7, 12)	6 (3, 9)	12 (6, 14)	7 (4, 11)	< 0.001
DT	4 (2, 6)	2 (0, 2)	2 (0, 3)	2 (0, 4)	< 0.001
MT	3 (1, 6)	2.5 (1, 6)	8 (5, 12)	3 (1, 6)	< 0.001
FT	0 (0, 2)	0 (0, 2)	0 (0, 0)	0 (0, 2)	0.006
BMI (kg/m²)	26.1 (22.1, 31.1)	29.2 (25.5, 32.4)	33.4 (26.5, 37.4)	28.7 (25.1, 32.8)	< 0.001
SBP (mmHg)	—	124.5 (114, 136)	135.5 (121, 153)	126.5 (116, 143)	0.009
DBP (mmHg)	—	83 (77, 91)	86 (81, 97)	84 (77, 93)	0.067
Categorical variables, n (%)					
Sex					0.153
Male	23 (41.8)	69 (51.5)	13 (35.1)	105 (46.5)	
Female	32 (58.2)	65 (48.5)	24 (64.9)	121 (53.5)	
Age group (years)					0.113
<18	3 (5.5)	2 (1.5)	3 (8.1)	8 (3.5)	
18–29	10 (18.2)	11 (8.2)	5 (13.5)	26 (11.5)	
30–44	22 (40.0)	50 (37.3)	9 (24.3)	81 (35.8)	
45–59	14 (25.5)	43 (32.1)	14 (37.8)	71 (31.4)	
≥60	6 (10.9)	28 (20.9)	6 (16.2)	40 (17.7)	

Continuous variables are presented as median (p25, p75) and compared across sites by Kruskal–Wallis test; categorical variables are presented as n (%) and compared by Pearson chi-square test. BMI was measured at all three sites; blood pressure measurement was added to the protocol from Wave 2 onwards and was therefore available at Sarada and Nawaka but not at Nadi. □ Hypertension defined by JNC8 criteria (systolic blood pressure ≥ 140 mmHg, diastolic blood pressure ≥ 90 mmHg, or current use of antihypertensive medication). One participant with a missing DMFT score is excluded from DMFT-derived categorical rows. DBP, diastolic blood pressure; DMFT, decayed, missing and filled teeth; DT, decayed teeth; FT, filled teeth; MT, missing teeth; SBP, systolic blood pressure.

Variable	Nadi	Sarada	Nawaka	Total	p-value
	(n = 55)	*(n = 134)*	*(n = 37)*	*(n = 226)*	
Toothbrushing frequency					< 0.001
<1/day	9 (16.4)	42 (31.3)	11 (29.7)	62 (27.4)	
1/day	40 (72.7)	90 (67.2)	14 (37.8)	144 (63.7)	
≥2/day	6 (10.9)	2 (1.5)	12 (32.4)	20 (8.8)	
Current tobacco use	17 (30.9)	25 (18.7)	12 (32.4)	54 (23.9)	0.082
Current alcohol use	15 (27.3)	61 (45.5)	15 (40.5)	91 (40.3)	0.067
BMI category					0.002
Underweight	3 (5.5)	4 (3.5)	2 (5.6)	9 (4.4)	
Normal	21 (38.2)	17 (14.9)	4 (11.1)	42 (20.5)	
Overweight	16 (29.1)	44 (38.6)	8 (22.2)	68 (33.2)	
Obese (BMI ≥ 30)	15 (27.3)	49 (43.0)	22 (61.1)	86 (42.0)	
Hypertension (JNC8)□	—	38 (36.5)	20 (58.8)	58 (42.0)	0.022
High caries burden (DMFT ≥ 4)	46 (85.2)	85 (63.4)	30 (81.1)	161 (71.6)	0.004
Any caries experience (DMFT ≥ 1)	50 (92.6)	122 (91.0)	33 (89.2)	205 (91.1)	0.854

Continuous variables are presented as median (p25, p75) and compared across sites by Kruskal–Wallis test; categorical variables are presented as n (%) and compared by Pearson chi-square test. BMI was measured at all three sites; blood pressure measurement was added to the protocol from Wave 2 onwards and was therefore available at Sarada and Nawaka but not at Nadi. □ Hypertension defined by JNC8 criteria (systolic blood pressure ≥ 140 mmHg, diastolic blood pressure ≥ 90 mmHg, or current use of antihypertensive medication). One participant with a missing DMFT score is excluded from DMFT-derived categorical rows. DBP, diastolic blood pressure; DMFT, decayed, missing and filled teeth; DT, decayed teeth; FT, filled teeth; MT, missing teeth; SBP, systolic blood pressure.

Dental caries burden

Median DMFT in the combined sample was 7.0 (IQR 4–11). Distributions differed by site (Kruskal–Wallis $p < 0.001$): median DMFT was 9.5 (IQR 7–12) at Nadi, 6.0 (IQR 3–9) at Sarada, and 12.0 (IQR 6–14) at Nawaka. The corresponding distributions are shown as violin plots in Fig. 4. The unadjusted proportion with high caries burden (DMFT ≥ 4) was 85.2% at Nadi, 63.4% at Sarada, and 81.1% at Nawaka (chi-square $p = 0.004$). The proportion with any caries experience (DMFT ≥ 1) exceeded 89% at every site. Untreated decayed teeth (DT) were observed in nearly all participants, with the highest median count of decayed teeth at Nadi (4, IQR 2–6) and lower counts at Sarada and Nawaka (each median 2). In contrast,

missing teeth attributable to caries (MT) reached a median of 8 (IQR 5–12) at Nawaka, substantially higher than at the other two sites. Filled teeth (FT) were uncommon overall (overall median 0), again with the lowest count at Nawaka.

Adjusted DMFT model

Results of the negative binomial regression model for total DMFT are shown in Table 2 and as a forest plot in Fig. 5. After adjustment for sex, age, toothbrushing, tobacco use, and alcohol use, participants examined at Sarada Medical Centre had a 34% lower expected DMFT compared with Nadi Hospital attendees (adjusted IRR 0.66, 95% CI 0.56–0.79; $p < 0.001$). DMFT at Nawaka was not statistically different from Nadi (IRR 1.04, 95% CI 0.81–1.34; $p = 0.73$). Age was the strongest single predictor of DMFT: each one standard deviation increase in age (approximately 16 years in this sample) was associated with a 25% higher DMFT (IRR 1.25, 95% CI 1.13–1.39; $p < 0.001$). Sex, toothbrushing frequency, tobacco use, and alcohol use did not show statistically significant adjusted associations with DMFT in this sample, although the point estimate for tobacco use (IRR 1.17, 95% CI 0.93–1.46) was directionally consistent with the published literature. A plot of raw residuals against predicted DMFT (Fig. 1) showed no systematic pattern, supporting the adequacy of the negative binomial specification, and the adjusted mean DMFT by site is shown in Fig. 2.

Table 2
Adjusted regression models for dental and cardiometabolic outcomes, Fiji 2025–2026.

Variable	Model A	Model B	Model C	Model D	Model E	Model F
	Total DMFT *(NB, IRR)*	**High caries *(logistic, OR)***	**DT/DMFT *(frac. logit, OR)***	**FT/DMFT *(frac. logit, OR)***	**Hypertension *(logistic, OR)***	**Obesity *(logistic, OR)***
Sitea						
Sarada vs Nadi	0.66 (0.56–0.79)***	0.25 (0.11–0.58)**	0.50 (0.33–0.75)**	1.48 (0.86–2.56)	ref (Sarada)b	ref (Sarada)b
Nawaka vs Nadi	1.04 (0.81–1.34)	0.63 (0.18–2.17)	0.30 (0.18–0.49)***	0.10 (0.03–0.36)***	—	—
Nawaka vs Sarada	—	—	—	—	2.28 (0.95–5.47)†	1.77 (0.82–3.79)
Sex (ref: Male)						
Female	1.08 (0.90–1.30)	1.01 (0.50–2.04)	1.12 (0.77–1.62)	1.25 (0.70–2.26)	0.46 (0.19–1.12)†	2.28 (1.09–4.78)*
Age (per 1 SD ≈ 16 years)						
Age z-score	1.25 (1.13–1.39)***	1.83 (1.23–2.73)**	0.66 (0.52–0.82)***	0.86 (0.63–1.19)	1.34 (0.89–2.02)	0.90 (0.63–1.26)
Toothbrushing (ref: <1/day)						
1/day	1.04 (0.85–1.26)	1.05 (0.50–2.21)	0.69 (0.45–1.05)	1.56 (0.82–2.95)	—	—
≥2/day	1.06 (0.79–1.42)	1.50 (0.30–7.51)	0.48 (0.24–0.95)*	2.66 (1.07–6.57)*	—	—
Tobacco use (ref: No)						
Yes	1.17 (0.93–1.46)	1.41 (0.59–3.38)	1.08 (0.72–1.61)	0.53 (0.28–1.02)†	0.56 (0.22–1.38)	1.36 (0.60–3.08)
Alcohol use (ref: No)						

Variable	Model A	Model B	Model C	Model D	Model E	Model F
	Total DMFT *(NB, IRR)*	**High caries *(logistic, OR)***	**DT/DMFT *(frac. logit, OR)***	**FT/DMFT *(frac. logit, OR)***	**Hypertension *(logistic, OR)***	**Obesity *(logistic, OR)***
Yes	1.03 (0.85–1.23)	0.67 (0.32–1.41)	1.03 (0.72–1.47)	1.06 (0.54–2.09)	0.77 (0.33–1.82)	0.89 (0.41–1.92)
Other covariates						
BMI (per 1 kg/m²)	—	—	—	—	1.06 (0.99–1.14)	—
N	**225**	**225**	**205**	**205**	**126**	**150**

Values are point estimates with 95% confidence intervals. **Model A**: total DMFT, negative binomial regression, incidence rate ratios (IRR). **Model B**: high caries burden (DMFT ≥ 4), logistic regression, odds ratios (OR). **Models C and D**: proportion of decayed teeth among caries-affected teeth (DT/DMFT) and care index (FT/DMFT), fractional logit regression (binomial family, logit link) restricted to participants with DMFT ≥ 1; OR. **Models E and F**: hypertension (JNC8 criteria) and obesity (BMI ≥ 30 kg/m²), logistic regression restricted to Wave 2 participants; OR. Model E (hypertension) had n = 126 after listwise deletion of participants with missing BMI or other model covariates; Model F (obesity) had n = 150. Toothbrushing frequency was omitted from Models E and F because of small-cell instability in the Wave 2 subset.

a Reference category for site varies by model. For Models A–D (dental outcomes, full sample), the reference site is Nadi Hospital; effect estimates for Sarada and Nawaka are contrasts versus Nadi. For Models E–F (cardiometabolic outcomes, Wave 2 only), Nadi was not visited during Wave 2 and therefore drops out; the reference site is Sarada, and the Nawaka row reports the contrast versus Sarada. **b** Cells marked “ref (Sarada)” indicate that Sarada serves as the reference category for that model.

All models used robust (sandwich) standard errors. *** p < 0.001; ** p < 0.01; * p < 0.05; † p < 0.10. BMI, body mass index; CI, confidence interval; DMFT, decayed, missing and filled teeth; DT, decayed teeth; FT, filled teeth; JNC8, Eighth Joint National Committee; NB, negative binomial; SD, standard deviation.

Table 3
Sensitivity analysis for total DMFT: negative binomial regression in the full sample versus adults aged ≥ 18 years.

Variable	Full sample*(n = 225)*	Adults ≥ 18 y*(n = 217)*
Site (ref: Nadi)		
Sarada	0.66 (0.56–0.79)***	0.64 (0.54–0.76)***
Nawaka	1.04 (0.81–1.34)	1.14 (0.92–1.42)
Sex (ref: Male)		
Female	1.08 (0.90–1.30)	1.03 (0.86–1.23)
Age (per 1 SD)		
Age z-score	1.25 (1.13–1.39)***	1.19 (1.08–1.31)***
Toothbrushing (ref: <1/day)		
1/day	1.04 (0.85–1.26)	1.07 (0.88–1.30)
≥2/day	1.06 (0.79–1.42)	1.01 (0.76–1.34)
Tobacco use (ref: No)		
Yes	1.17 (0.93–1.46)	1.11 (0.89–1.38)
Alcohol use (ref: No)		
Yes	1.03 (0.85–1.23)	1.00 (0.83–1.19)
Dispersion parameter (α)	0.29 (0.20–0.44)	0.25 (0.16–0.38)
Number of observations	**225**	**217**

Values are incidence rate ratios (IRR) with 95% confidence intervals from negative binomial regression with robust (sandwich) standard errors. Site and age effects are materially unchanged when the small paediatric subgroup (n = 8) is excluded, confirming that the main findings are not driven by paediatric attendees. *** $p < 0.001$. CI, confidence interval; DMFT, decayed, missing and filled teeth; SD, standard deviation.

In an exploratory model incorporating a site-by-age product term (Fig. 3), the slope of DMFT with age was steeper at Nadi and Nawaka than at Sarada. Confidence bands were wide at the extremes, particularly at Nawaka where the sample was smallest, and the formal interaction was not statistically significant. This finding is therefore treated as descriptive only.

Secondary outcomes: high caries, untreated proportion and care index

In the logistic regression for high caries burden (Table 2), Sarada was again associated with lower odds compared with Nadi (OR 0.25, 95% CI 0.11–0.58; p = 0.001), while Nawaka did not differ significantly (OR 0.63, 95% CI 0.18–2.17). The age effect was substantial, with an OR of 1.83 (95% CI 1.23–2.73; p = 0.003) per standard deviation increase.

The pattern for untreated decay was more nuanced. In the fractional logit model for the proportion of decayed teeth among caries-affected teeth (Table 2), participants at Sarada (OR 0.50, 95% CI 0.33–0.75) and at Nawaka (OR 0.30, 95% CI 0.18–0.49) both showed a substantially lower untreated proportion than Nadi attendees. Taken on its own, this might suggest that the outreach sites were less affected by unmet treatment need. The companion analysis of the care index (FT/DMFT) clarifies the picture (Table 2): the care index was markedly lower at Nawaka than at Nadi (OR 0.10, 95% CI 0.03–0.36; p < 0.001), with no statistically significant difference between Sarada and Nadi. Read together with the very high median count of missing teeth at Nawaka, the lower untreated proportion at the most remote site reflected tooth loss rather than restorative treatment received.

Cardiometabolic findings

BMI was available at all three sites and showed a clear site gradient, with median BMI of 26.1 kg/m² at Nadi, 29.2 kg/m² at Sarada, and 33.4 kg/m² at Nawaka (Kruskal–Wallis p < 0.001). Across the 205 participants with valid BMI data, 42.0% met the criterion for obesity, with the highest unadjusted prevalence at Nawaka (61.1%). Blood pressure was available for 138 Wave 2 participants from Sarada and Nawaka. Of these, 42.0% met JNC8 criteria for hypertension, with a higher unadjusted prevalence at Nawaka (58.8%) than at Sarada (36.5%; chi-square p = 0.022). In the adjusted logistic regression for hypertension (Table 2, Model E; n = 126 after listwise deletion of participants with missing BMI or other model covariates), the odds of hypertension was 2.28-fold higher at Nawaka than at Sarada (95% CI 0.95–5.47; p = 0.07); in the corresponding model for obesity (Table 2, Model F; n = 150), the odds were 2.28-fold higher in women than in men (95% CI 1.09–4.78; p = 0.03). Both Wave 2 models were limited by sample size.

Sensitivity analysis

When the negative binomial DMFT model was refitted restricted to adults aged 18 years and over (n = 217), the site and age effects remained substantively unchanged (Sarada IRR 0.64, 95% CI 0.54–0.76; age IRR 1.19, 95% CI 1.08–1.31; Table 3), confirming that the main findings were not driven by the small paediatric subgroup. Substantive conclusions were also robust to choice of count model: in both zero-inflated negative binomial and hurdle specifications (Supplementary Tables S1 and S2), site, age, and tobacco coefficients were stable in direction and magnitude, although AIC and BIC slightly favoured the ZINB and hurdle models over the plain negative binomial. We retained the negative binomial as the primary specification because there is no clearly motivated structural-zero process in a sample where the proportion of zeros (8.9%) is consistent with what a single, properly overdispersed count distribution would produce.

Discussion

This cross-sectional analysis of 226 individuals examined at three Fijian sites during a Taiwanese humanitarian dental mission shows a heavy burden of dental caries: median DMFT of 7.0, more than seven in ten participants meeting the high-caries threshold, and untreated decay observed in nearly every individual with caries experience. The age gradient was steep, with each standard deviation increase in age associated with a 25% higher DMFT and an 83% higher odds of a high caries burden. After adjustment for individual-level risk factors, attendees at Sarada Medical Centre had lower DMFT than the comparable hospital-clinic group at Nadi, and the most striking site finding was the very low care index at Nawaka, where missing teeth dominated the dental record.

The overall caries severity observed here is broadly consistent with the picture painted by the recent scoping review of Pacific oral health [4] and with the hospital-based study by Tiim and colleagues, in which dental caries was the underlying cause in roughly nine of every ten odontogenic infections presenting to divisional hospitals in Fiji [7]. The median DMFT in our sample exceeds that reported for several other middle-income settings in the Global Burden of Disease 2017 study [1], although direct comparison is complicated by differences in age structure and sampling frame. Earlier Fijian work has tended to focus on schoolchildren or institutionalised elderly residents [8, 9, 15], leaving a notable gap for the community-dwelling adults who present during outreach activities; the present data go some way to filling that gap, even from a non-probabilistic sample.

The site differences need to be interpreted with care. The lower adjusted DMFT at Sarada compared with Nadi is unlikely to reflect a true biological difference between the two communities, which are geographically and demographically similar. The most plausible explanation is selection: the Nadi Hospital walk-in clinic during the mission was, in effect, a self-referral population presenting because of symptomatic dental disease, whereas the Sarada cohort was assembled in a community medical centre setting where the threshold for examination was lower. The implication is not that Sarada residents have better oral health than Nadi residents, but that hospital-attending populations during short-term humanitarian missions are not representative of community caries levels, a point that has long been made about short-term medical mission research more generally.

The Nawaka findings warrant separate comment. Nawaka participants did not have a significantly higher adjusted DMFT than Nadi attendees, but they had an extremely low care index (FT/DMFT) and a very high count of missing teeth. The lower proportion of untreated decay at Nawaka, taken in isolation, could be misread as evidence of better treatment access. The very high count of missing teeth together with a near-absent restorative record is, instead, consistent with limited access to restorative dentistry at this site. Whether the missing teeth represent extractions performed in the absence of restorative options, or progression of untreated disease to tooth loss, cannot be determined from cross-sectional records. The combination of high MT and low FT is in any case a recurring feature of rural and remote populations in low- and middle-income settings, and is consistent with the Fijian workforce and equipment data summarised in the recent Pacific oral health scoping review [4].

Two points about prevention are worth drawing out. The absence of community-level water fluoridation in Fiji, documented across all four divisions by Prasad and colleagues [5], leaves the population reliant on individual-level preventive behaviours and on the dental workforce for both prevention and treatment. The high proportion of participants reporting brushing less than once per day at Sarada and Nawaka indicates that this prevention layer is thin in practice. The cardiometabolic findings — overall obesity prevalence of 42% and hypertension in 42% of the Wave 2 subset — also align closely with the community-level NCD risk factor profile previously reported in western Fiji by Gyaneshwar and colleagues [11], and are in line with the common risk factor approach to oral health [10], which has long argued for joint rather than parallel planning of dental and broader NCD prevention activities.

Several relationships that have been documented in larger meta-analyses were not statistically significant in our model. Tobacco use, for which meta-analytic evidence indicates a positive association with DMFT in adults [16], showed a directionally consistent but non-significant effect (IRR 1.17, 95% CI 0.93–1.46), most likely because the present sample lacks power to detect a moderate effect against an already-high baseline DMFT. Toothbrushing frequency also did not show a clear adjusted effect, although self-reported brushing data are known to be vulnerable to social desirability bias.

Strengths of this analysis include the use of a single calibrated examiner across both mission waves and all three sites, with intra-examiner Cohen's kappa of 0.92 and 0.94 indicating near-perfect agreement and removing inter-examiner variability as a source of measurement error. Other strengths are the use of a standardised WHO scoring protocol, the application of regression methods appropriate for an overdispersed count outcome [13], the use of robust standard errors throughout, the pre-specification of a sensitivity analysis restricted to adults, and the cross-checking of conclusions against alternative count specifications. The integration of cardiometabolic measurements during Wave 2 has allowed us to describe the co-occurrence of dental and cardiovascular risk in a way that single-discipline missions do not typically capture.

This study has several limitations. The sample was a convenience sample of mission attendees rather than a probability sample of the underlying communities, so prevalence estimates should be read as descriptions of those who attended, not as population estimates. The Nadi sample was a hospital walk-in population and is unlikely to be representative of the community surrounding the hospital. Blood pressure data were available only from Wave 2 and only from Sarada and Nawaka, so the hypertension analysis could not be adjusted for Nadi. Dietary intake — in particular free-sugar consumption — was not recorded, despite the central role of dietary sugars in dental caries aetiology [2]. Finally, no separate Fijian institutional review board approval was sought because Nadi Hospital does not operate such a board; the study was carried out under the MacKay Memorial Hospital IRB approval and with the full cooperation of the local clinical and outreach teams.

For future mission cycles, three operational implications follow from the present data. First, the very low care index at Nawaka argues for shifting at least part of the outreach effort from extraction-led care toward atraumatic restorative treatment and, where feasible, portable restorative dentistry. Second, brief

dietary screening should be added to the questionnaire, so that the free-sugar exposure that is presumed to drive caries in this setting can be measured directly rather than inferred. Third, the high prevalence of hypertension and obesity in the Wave 2 subset supports the planned expansion of the family medicine team's role within future dental missions; integrated screening is feasible within the existing operational footprint and would allow Fijian patients to gain multiple benefits from a single visit.

Conclusions

Across three Fijian communities visited during two waves of a Taiwanese humanitarian dental mission in 2025–2026, dental caries was nearly universal and severity rose steeply with age. The most remote outreach site, Nawaka, was characterised not by higher caries severity than the hospital-based comparator but by an almost complete absence of restorative care, with extracted teeth dominating the dental record. The high concurrent prevalence of hypertension and obesity supports the case for integrated dental and cardiometabolic outreach in future missions to the region.

Abbreviations

BMI
body mass index
CI
confidence interval
DBP
diastolic blood pressure
DMFT
decayed, missing and filled teeth
DT
decayed teeth
FT
filled teeth
GLM
generalised linear model
IRR
incidence rate ratio
JNC8
Eighth Joint National Committee
MT
missing teeth
NCD
noncommunicable disease
OR
odds ratio

SBP
systolic blood pressure
SD
standard deviation
WHO
World Health Organization
ZINB
zero-inflated negative binomial.

Declarations

Ethics approval and consent to participate

The study was reviewed and approved by the Institutional Review Board of MacKay Memorial Hospital, Taipei, Taiwan (approval number 25MMHIS307e), with a three-year approval period. Nadi Hospital, the local partner institution in Fiji, does not maintain a separate institutional review board; the study was therefore carried out under the MacKay Memorial Hospital IRB approval, with the full operational cooperation of the dental and clinical staff at Nadi Hospital and Sarada Medical Centre, and of the outreach team dispatched by Nadi Hospital to Nawaka. Written informed consent was obtained from each adult participant. For participants under 18 years of age, written informed consent was obtained from a parent or legal guardian, and assent was obtained from the child. The study followed the ethical principles of the Declaration of Helsinki.

Trial registration

Clinical trial number: not applicable. This study is an observational, cross-sectional field assessment of oral health (DMFT and oral hygiene indices) and selected cardiometabolic indicators carried out during a humanitarian dental mission, with no therapeutic intervention, randomisation, or allocation to study arms; prospective registration on a clinical trial registry was therefore not applicable.

Consent for publication

Not applicable. No individually identifiable images, clinical photographs, or personal details are reported in this article.

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

ETY and CCY contributed equally to this work and share first authorship. ETY conceived the study, performed all dental examinations and data recording across both mission waves, and drafted the manuscript. CCY contributed to data curation, designed the analysis plan, conducted the statistical analyses, and drafted the manuscript. SYL contributed to data curation, clinical review of the dental records, and critical revision of the manuscript. KZT supervised the final statistical analysis and contributed to drafting. CYC and CJL provided departmental oversight, contributed to methodological guidance, and reviewed the manuscript. WT, as corresponding author, provided overall mission oversight, supervised the analysis plan, and critically revised the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

The de-identified dataset analysed during the current study is available from the corresponding author on reasonable request, and subject to a data-use agreement consistent with the approved IRB protocol.

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Figures

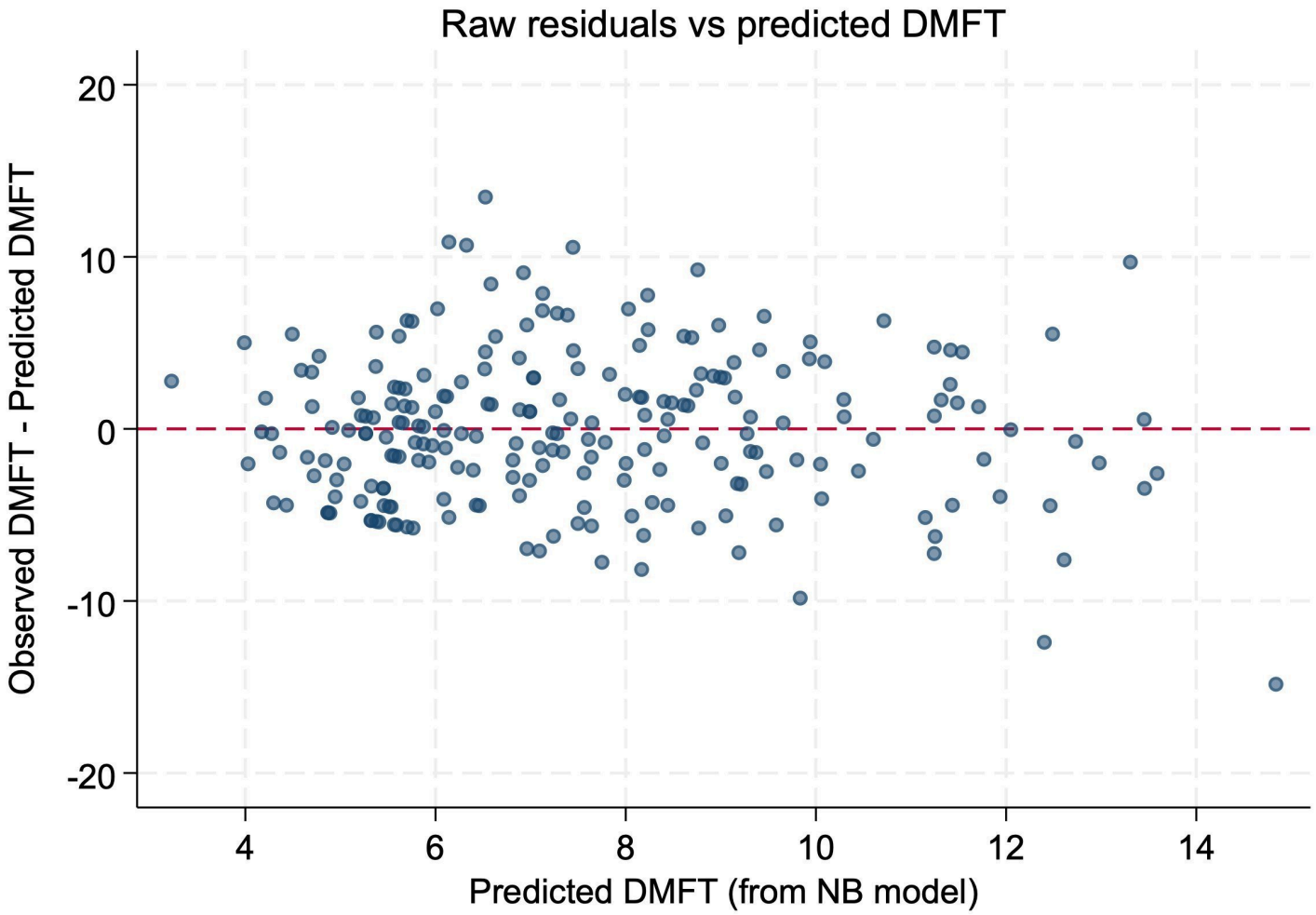


Figure 1

Raw residuals against predicted DMFT from the negative binomial regression model. The absence of systematic pattern around the zero line supports the adequacy of the negative binomial specification.

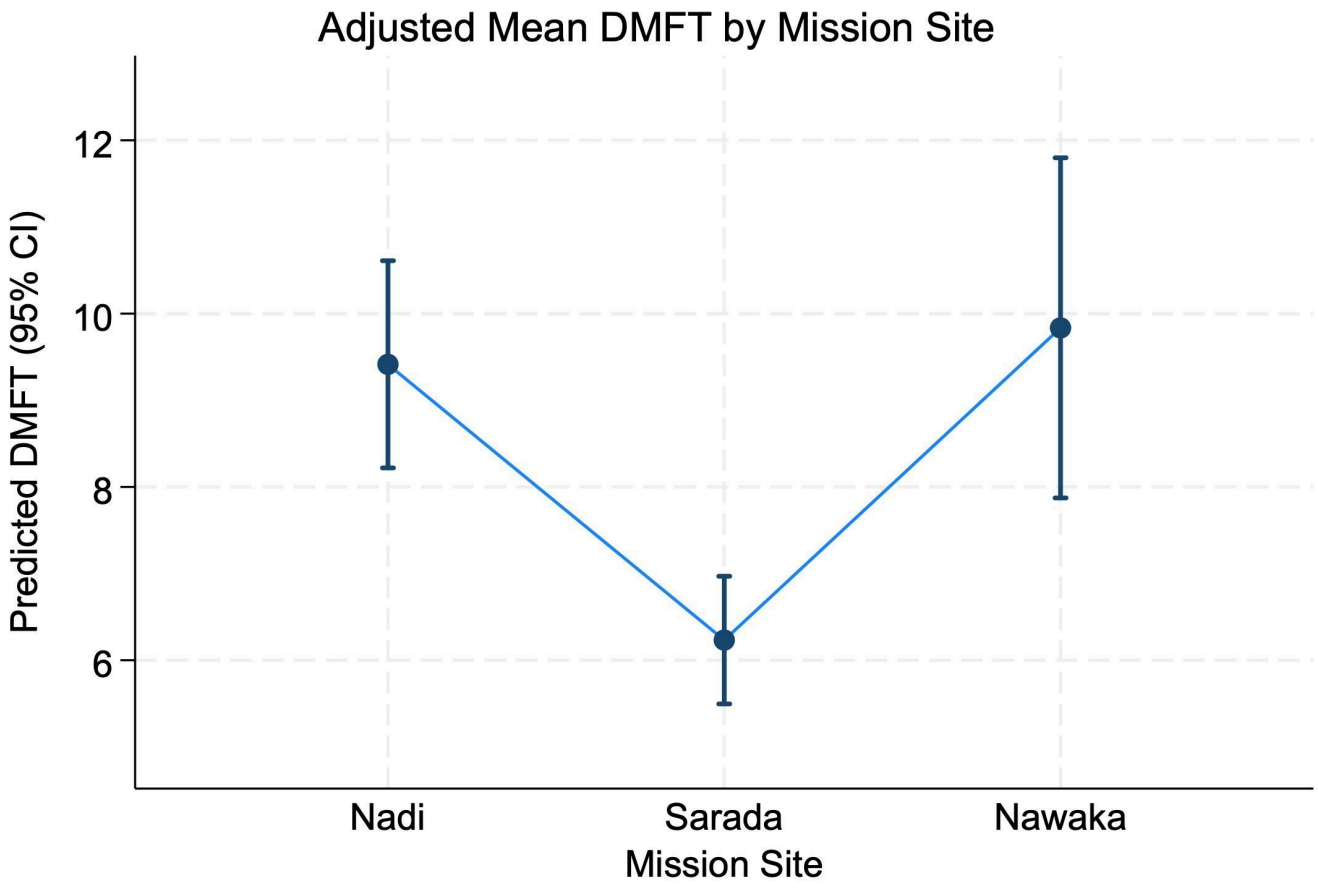


Figure 2

Adjusted mean DMFT by mission site (with 95% confidence intervals) derived from the negative binomial regression model. Sarada Medical Centre showed a significantly lower adjusted mean DMFT than Nadi Hospital; Nawaka did not differ significantly from Nadi.

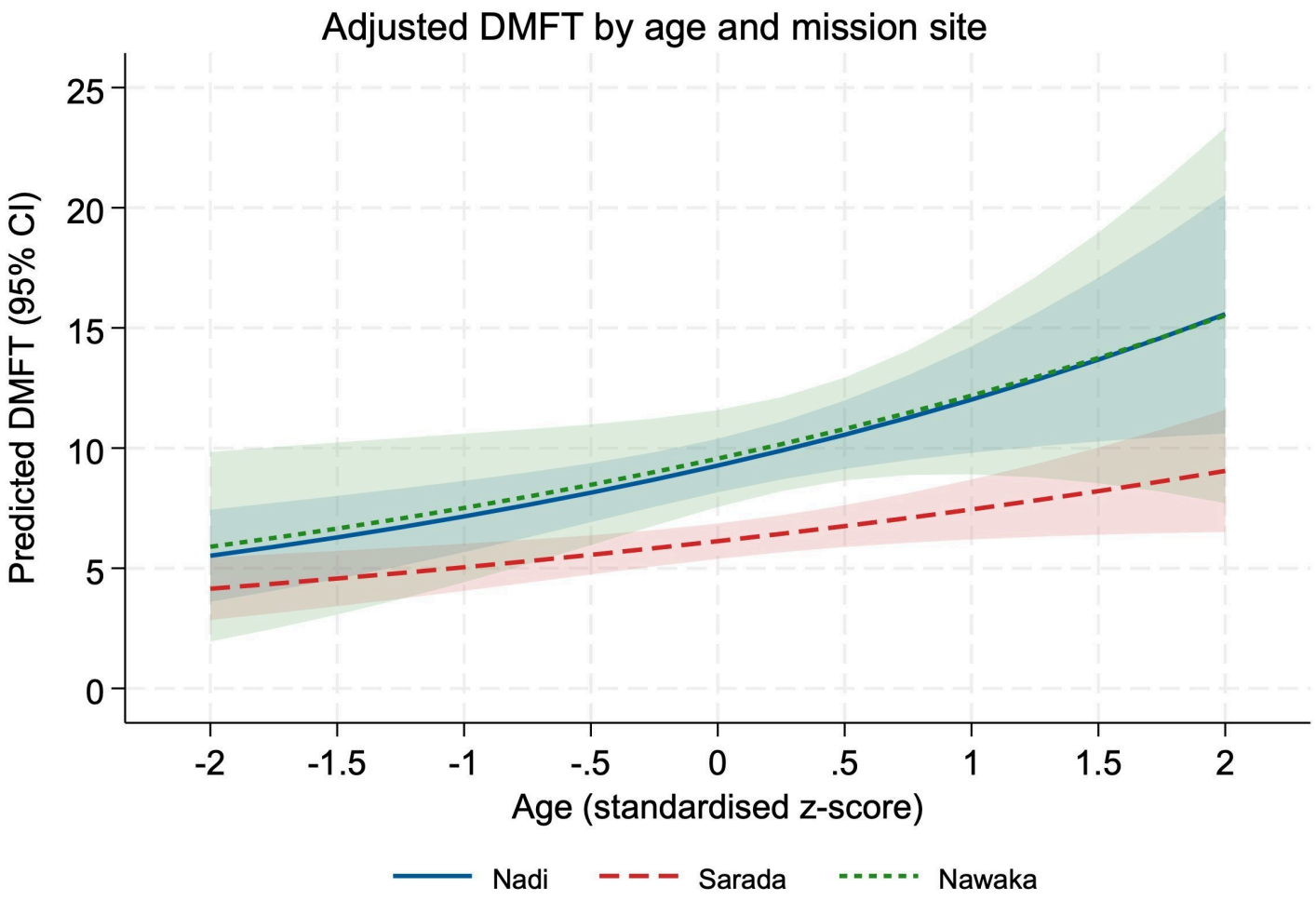


Figure 3

Predicted DMFT by standardised age and mission site (with 95% confidence intervals) from an exploratory model including a site-by-age product term. Confidence bands widen at the extremes of the age distribution; the formal interaction was not statistically significant, and the plot is presented for descriptive purposes only.

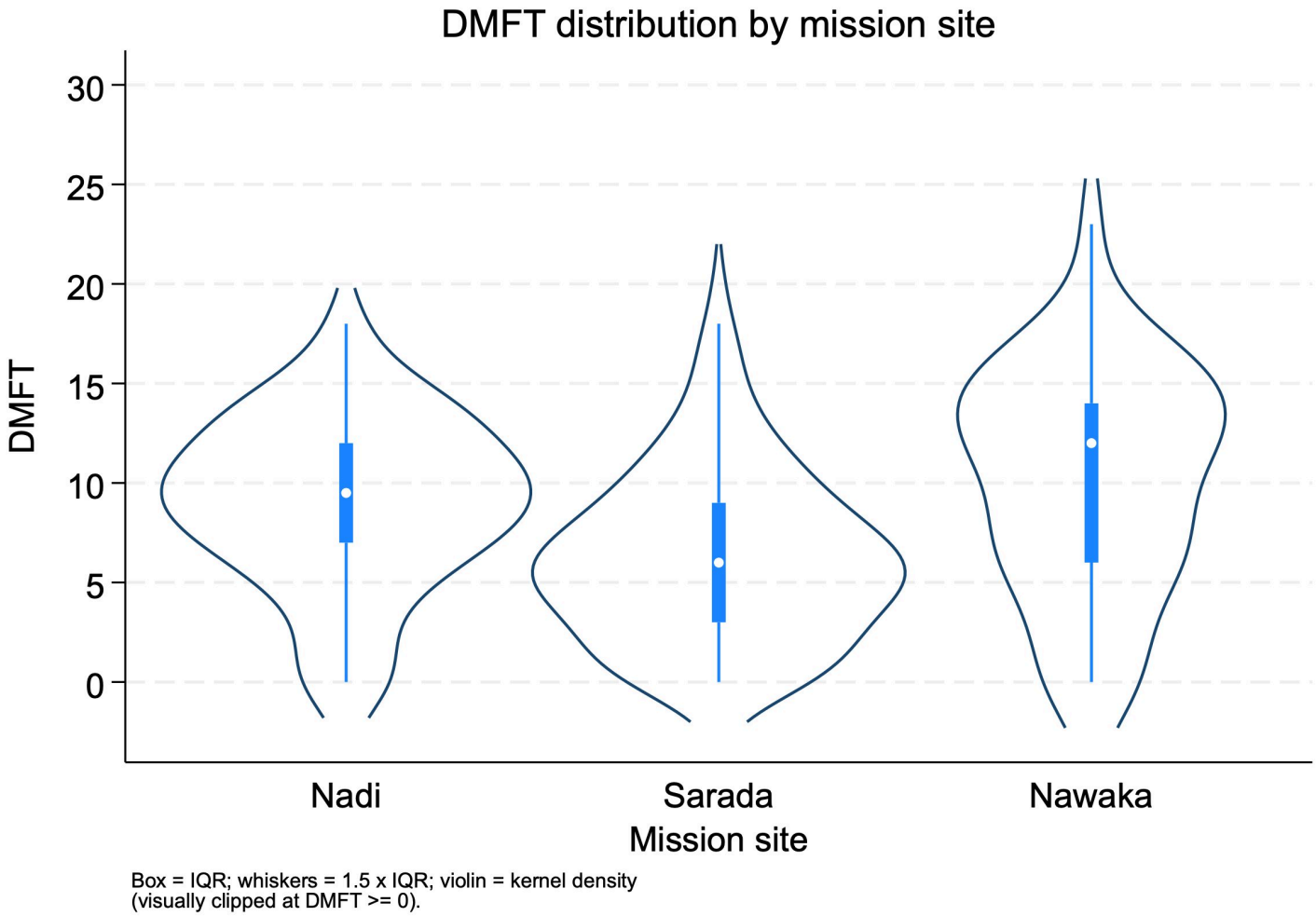


Figure 4

Distribution of DMFT by mission site. Boxes indicate the interquartile range, whiskers extend to 1.5 × IQR, and the surrounding violin shape shows the kernel density estimate.

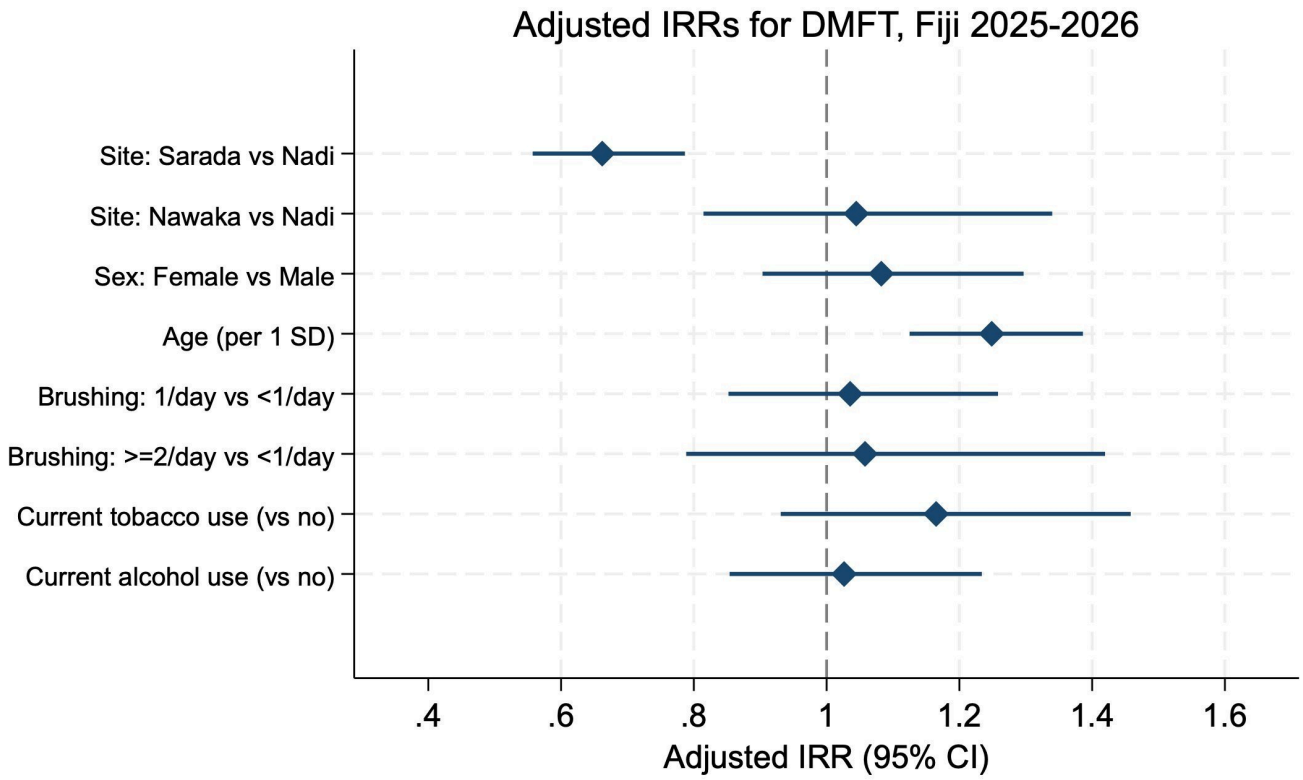


Figure 5

Forest plot of adjusted incidence rate ratios (IRR) with 95% confidence intervals from the primary negative binomial regression model for DMFT, Fiji 2025–2026.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SuppTableS1ModelSelection.docx
- SuppTableS2SensitivityZINBHurdle.docx