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SUPPLEMENTARY MATERIAL

Childhood Immunization Coverage in Libya: Trends, DTP Dropout and a Zero-Dose Proxy Based on WHO/UNICEF Estimates, 2000–2025

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Supplementary File S1. GATHER checklist

Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER): location of each item in the article.

No.	GATHER checklist item	Location in manuscript / reporting status
Objectives and funding		
1	Define the indicators, populations, geographic area, and time period for which estimates are made.	Abstract and Introduction; Methods Sections 2.1–2.3. The study describes national immunization coverage indicators in Libya from 2000 to 2025.
2	Specify the funding sources for the work.	Declarations, Funding. This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors.
Data inputs		
3	Describe how the data were identified and accessed.	Methods Section 2.1. Data were obtained from the WHO/UNICEF Estimates of National Immunization Coverage (WUENIC), 2025 revision, released on 15 July 2026.
4	Specify the inclusion and exclusion criteria. Identify any ad hoc exclusions.	Methods Section 2.1. Available national-level vaccine indicators for Libya during 2000–2025 were included. Missing indicator-year observations were not treated as available estimates.
5	Provide information on all included data sources and their main characteristics.	Methods Section 2.1 and References. The WUENIC dataset included annual estimates, administrative coverage, government estimates, previous revision estimates, confidence-grade codes, numbers of vaccinated children, target populations, surviving infants, and country-specific comments.
6	Identify and describe categories of input data that have potentially important biases.	Methods Section 2.1 and Discussion. Relevant limitations include discrepancies between WUENIC and administrative or government-reported coverage, vaccine stockouts, service interruptions, population denominator uncertainty, and assumptions used in the estimation process.
7	Describe and provide sources for any other data inputs that contributed to the analysis but were not synthesized.	Methods Section 2.1. Surviving-infant population estimates from the United Nations Population Division were used where available to derive estimated numbers of children not reached by vaccination.

No.	GATHER checklist item	Location in manuscript / reporting status
8	Provide data inputs in a file format from which they can be efficiently extracted, including relevant metadata, or explain how they can be accessed.	Declarations, Data availability; Supplementary Tables S1 and S2. The original WUENIC dataset is publicly available from WHO/UNICEF (https://immunizationdata.who.int/); the extracted and derived values used in the analysis are reported in Tables 1–5 of the article.
Data analysis		
9	Provide a conceptual overview of the data analysis method.	Methods Sections 2.2–2.4. The analysis involved descriptive assessment of annual vaccine coverage, comparison of available data sources, examination of country-specific comments, and calculation of DTP dropout and a coverage-based zero-dose proxy.
10	Provide a detailed description of all analysis steps, including mathematical formulae and relevant data processing procedures.	Methods Section 2.3. Absolute DTP dropout = DTP1 − DTP3. Relative DTP dropout = [(DTP1 − DTP3) / DTP1] × 100. Zero-dose proxy = 100 − DTP1 coverage. Estimated number of zero-dose children = surviving infants × (100 − DTP1 coverage) / 100.
11	Describe how candidate models were evaluated and how final models were selected.	Not applicable. No new statistical or mathematical estimation models were developed; this was a descriptive secondary analysis of published national estimates.
12	Provide the results of model performance evaluation and relevant sensitivity analyses, if performed.	Not applicable. No model performance evaluation or sensitivity analysis was conducted.
13	Describe methods for calculating uncertainty and state which sources of uncertainty were and were not accounted for.	Section 4.6 (Strengths and limitations). No new uncertainty intervals were calculated. WUENIC confidence-grade codes were extracted for every estimate and are reported in Supplementary Table S1; grade 1 is the lowest grade of confidence.
14	State how analytical or statistical source code used to generate estimates can be accessed.	Declarations, Data availability. Derived indicators were calculated from the published WUENIC estimates using the formulae given in section 2.3; no statistical modelling code was used.
Results and Discussion		
15	Provide published estimates in a file format from which data can be efficiently extracted.	Results, Tables 1–5 and Figs. 1–4; Supplementary Tables S1 and S2.
16	Report a quantitative measure of the uncertainty of the estimates, such as uncertainty intervals.	Numerical uncertainty intervals were not available in the analyzed dataset and were not independently calculated. This limitation is acknowledged in the Discussion.
17	Interpret results in light of existing evidence. If updating previous estimates, describe reasons for changes in estimates.	Discussion. Findings are interpreted in relation to documented vaccine stockouts, service interruptions, catch-up activities, differences between data sources, and country-specific WUENIC comments.
18	Discuss limitations of the estimates, including modelling assumptions and data limitations that affect interpretation.	Section 4.6 (Strengths and limitations). Limitations include reliance on national-level estimates, discrepancies between data sources, denominator uncertainty, estimation assumptions, and the use of a coverage-based zero-dose proxy rather than individual vaccination records.

Reference: Stevens GA, Alkema L, Black RE, Boerma JT, Collins GS, Ezzati M, et al. Guidelines for accurate and transparent health estimates reporting: the GATHER statement. Lancet. 2016;388:e19–e23. doi:10.1016/S0140-6736(16)30388-9.

Supplementary Table S1. WUENIC confidence-grade codes by vaccine indicator and year, Libya, 2000–2025

Year	BCG	DTP1	DTP3	HepB3	Hib3	IPV1	IPVC	MCV1	MCV2	PCVC	RCV1	RotaC
2000	1	1	1	**2**	—	—	—	1	—	—	1	—
2001	1	1	1	1	—	—	—	1	1	—	1	—
2002	1	1	1	1	—	—	—	**2**	1	—	**2**	—
2003	1	1	1	1	—	—	—	1	1	—	1	—
2004	**3**	**3**	**3**	**2**	—	—	—	**3**	**2**	—	**3**	—
2005	**3**	**3**	**3**	**2**	—	—	—	**3**	**2**	—	**3**	—
2006	**3**	**3**	**3**	**2**	—	—	—	**3**	**2**	—	**3**	—
2007	**3**	**3**	1	**2**	1	—	—	**3**	**2**	—	**3**	—
2008	1	1	1	1	1	—	—	**3**	**2**	—	**3**	—
2009	1	1	1	1	1	—	—	1	1	—	1	—
2010	1	1	1	1	1	—	—	1	1	—	1	—
2011	1	1	1	1	1	—	—	1	1	—	1	—
2012	1	1	1	1	1	—	—	1	1	—	1	—
2013	1	1	1	1	1	—	—	1	1	—	1	—
2014	1	1	1	1	1	—	—	1	1	1	1	1
2015	1	1	1	1	1	1	—	1	1	1	1	1
2016	1	1	1	1	1	1	—	1	1	1	1	1
2017	1	1	1	1	1	1	—	1	1	1	1	1
2018	1	1	1	1	1	1	—	1	1	1	1	1
2019	1	1	1	1	1	1	—	1	1	1	1	1
2020	1	1	1	1	1	1	—	1	1	1	1	1
2021	1	1	1	1	1	1	1	1	1	1	1	1
2022	1	1	1	1	1	1	1	1	1	1	1	1
2023	1	1	1	1	1	1	1	1	1	1	1	1
2024	1	1	1	1	1	1	1	1	1	1	1	1
2025	1	1	1	1	1	1	1	1	1	1	1	1

Shading: grade 3 grade 2 grade 1 (unshaded) — no estimate

Codes are reproduced as reported in the WUENIC 2025 revision dataset; grade 1 (one star) is the lowest grade of confidence and grade 3 the highest. — indicates that no estimate was available for that indicator and year. Codes of 2 or 3 occur only between 2000 and 2008; every estimate from 2009 onward carries grade 1. BCG, bacille Calmette–Guérin vaccine; DTP1/DTP3, first/third dose of diphtheria–tetanus–pertussis-containing vaccine; HepB3, third dose of hepatitis B vaccine; Hib3, third dose of *Haemophilus influenzae* type b vaccine; IPV1, first dose of inactivated poliovirus vaccine; IPVC, inactivated poliovirus vaccine completion; MCV1/MCV2, first/second dose of measles-containing vaccine; PCVC, pneumococcal conjugate vaccine completion; RCV1, first dose of rubella-containing vaccine; RotaC, rotavirus vaccine completion.

Supplementary Table S2. Summary of country-specific evidence and estimation comments for selected years, Libya

Year	Summary of WUENIC country comments
2011	No accepted empirical data; estimate based on interpolation. Country comments state actual coverage was likely lower during civil strife.
2014	Estimates informed by reported administrative data; comments note unexplained adjustments to government official estimates for several indicators.
2017	Estimates informed by reported administrative data; comments note challenges to the estimates.
2018	Three months of vaccine stockouts reported nationally and subnationally; WUENIC estimate reduced using an extreme assumption of no service delivery during the stockout period.
2019	Three months of stockouts reported; estimate reduced by 25 percentage points based on a strong assumption of severe service disruption. Comments cite ongoing conflict and instability.
2020	Three to four months of stockouts reported depending on indicator; a 25-percentage-point reduction was applied under the assumption of severe service disruption.
2021	Two months of stockouts reported for some indicators; estimates also informed by related antigen estimates for selected indicators.
2022	Three months of stockouts reported. Government official estimates were based on average administrative coverage from previous years; comments cite reports of up to 90% of PHC facilities closed in some areas in 2021.
2023	Six months of stockouts reported; vaccines received late in the year and catch-up activities conducted. Country comments state WUENIC may underestimate true coverage and cite 19% of health facilities not providing immunization services.
2024	Reported coverage may be overestimated because administered doses increased early in the year following catch-up activities after 2023 stockouts; three months of stockout reported for some indicators.
2025	Two months of stockout reported for BCG. Comments warn that reported coverage may be overestimated because routine and catch-up doses are difficult to distinguish. Preliminary MICS 2024–2025 cohort findings are reported by antigen.

Country comments summarize the information and assumptions relevant to interpretation and do not reproduce the complete WHO/UNICEF documentation. PHC, primary health care; MICS, Multiple Indicator Cluster Survey.