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Childhood Vaccination Coverage and Adult Immunization Policy: An Exploratory Comparison of Egypt, Canada, and the United States

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Abstract

Introduction

Childhood immunization coverage is measured in a comparatively standardized way, whereas adult vaccination is documented through four distinct dimensions: recommendation, program availability, uptake, and dose distribution. This study compared childhood coverage rankings with the documented dimensions of adult vaccination policy in three deliberately contrasting countries to examine whether they aligned. The comparison was descriptive and was not intended to test predictive relationships or establish statistical association.

Methods

We analyzed a fixed extraction of the 2024 revision of the WHO/UNICEF Estimates of National Immunization Coverage (WUENIC) for diphtheria-tetanus-pertussis third-dose (DTP3) and measles-containing vaccine first-dose (MCV1) in Egypt, Canada, and the United States from 2015 to 2024. We calculated descriptive statistics and exploratory ordinary least-squares trends with Newey-West standard errors (lag 1). Sensitivity analyses used t-based intervals, conventional standard errors, and Holm adjustment for six tests. Adult evidence from official schedules, guidance, national surveys, and published Egyptian studies was organized qualitatively into four constructs: recommendation, availability, uptake, and distribution. Adult policy breadth was described, not scored. A post hoc analysis compared DTP3 trends for 2015-2024 with those for 2000-2024 in Egypt and Canada.

Results

Egypt had the highest mean WUENIC coverage for both DTP3 (95.2%) and MCV1 (94.9%), followed by the United States (94.1% and 91.6%) and Canada (91.5% and 90.4%). The official sources reviewed documented broader adult recommendation frameworks for Canada and the United States than for Egypt, where adult uptake had been measured only for COVID-19 and in healthcare workers. Adult uptake estimates were not comparable across the three countries. Egypt's DTP3 trend was +0.364 percentage points per year for 2015-2024 (95% CI 0.277 to 0.450) but -0.132 for 2000-2024 (95% CI -0.213 to -0.050), showing sensitivity to the time window.

Conclusion

Childhood coverage rankings did not align with the documented breadth of adult immunization policy. Because adult-policy documentation and uptake measurement differed substantially, these results cannot demonstrate an inverse relationship or rank the overall performance of national immunization systems. Childhood coverage and the four adult dimensions should be reported separately.

Categories: Public Health, Internal Medicine, Infectious Disease
Keywords: adult vaccination, canada, dtp3, ecological analysis, egypt, health systems, immunization coverage, life-course immunization, measles-containing vaccine, united states

Introduction

Childhood immunization protects against measles, pertussis, diphtheria, tetanus, and much else besides. Adult programs usually cover influenza, pneumococcal disease, zoster, respiratory syncytial virus (RSV), hepatitis B, booster doses, and vaccines indicated by pregnancy, occupation, travel, or medical risk. Protection accumulates across a lifetime. Measurement does not.

WHO/UNICEF Estimates of National Immunization Coverage (WUENIC) provide annual national estimates for diphtheria-tetanus-pertussis third-dose (DTP3) and measles-containing vaccine first-dose (MCV1) for most countries [1,2]. These are not simple counts. They are estimates that incorporate country reports,

surveys, contextual information, and expert review. They are annually revised and should be interpreted based on their country-specific documentation.

Adult vaccination is more difficult to compare. This is evident from the observation that Canada provides national guidance, while provinces and territories are the ones that determine many delivery arrangements [3]. The United States maintains a consolidated adult schedule, but uptake varies by jurisdiction and population [4,5]. Publicly available Egyptian adult-uptake information was less complete among the sources reviewed. Recommendation, program availability, measured uptake, and dose distribution are distinct quantities and should not be treated interchangeably.

Childhood coverage may be used as shorthand for immunization-system performance because it is easier to compare internationally. We examined whether that shorthand was consistent with the documented adult-policy platform in the three selected countries.

Egypt, Canada, and the United States were not selected for representativeness but for illustrative comparison. Egypt was chosen because the authors' institutional location gave closer familiarity with and ability to verify the Egyptian evidence base. Canada and the United States were chosen as two high-income countries with different health-system models (single-payer provincial versus mixed public-private), so that high-income settings were not treated as a single category. All three countries publish sufficiently detailed public data, WUENIC estimates, and national adult-policy documentation to support this descriptive comparison [1,4,6]. The three countries do not represent their income groups, and because their selection was purposive, no population-level inferences should be drawn from them.

This paper makes two descriptive contributions. First, it places childhood coverage and documented adult immunization policy side by side for the same three countries. Second, it applies a four-construct framework that separates recommendation, availability, uptake, and distribution. The aims were to compare DTP3 and MCV1 estimates during 2015-2024 and to describe adult policies without treating policy availability as confirmed uptake. The design of this study is mainly exploratory, ecological, and descriptive, and it cannot establish particular causes, prediction, or association.

Objectives

The primary objective was to describe the breadth of publicly documented adult vaccination policy in Egypt, Canada, and the United States, assessed qualitatively as the range of vaccines and adult target groups covered by official recommendations; no quantitative or validated breadth score was constructed. The secondary objectives were (1) to identify which of the four constructs (recommendation, availability, uptake, and distribution) the reviewed adult sources documented in each country, and (2) to describe trends in childhood DTP3 and MCV1 coverage from 2015 to 2024, as context.

Materials And Methods

Design and data sources

This study was an exploratory descriptive analysis of collected official data and policy sources. None of the information used was at the individual level.

Childhood coverage data came from a fixed extraction of the WUENIC 2024 revision for 2015-2024, released on 15 July 2025 [1]; the annual values used are listed in Appendix A, and the descriptive statistics were recomputed from them in Appendix B. The release, country filters, antigen definitions, and study period were held constant. Later revisions were not combined with this statistical endpoint.

Adult-policy information was drawn from the WHO Immunization Data portal, the 2025 US adult immunization schedule, the Canadian Immunization Guide and National Advisory Committee on Immunization (NACI) guidance, and national respiratory-vaccination surveys, the WHO COVID-19 vaccination dashboard, and published Egyptian studies and expert guidance [2-10]. This was a targeted official-source review rather than a systematic review; consequently, failure to identify a national estimate must not be interpreted as proof that no such estimate exists.

Identification and selection of adult sources

Adult sources were identified through a targeted search of official websites between June 2025 and July 2026: the WHO Immunization Data portal; the US CDC; the Public Health Agency of Canada (Canadian Immunization Guide, NACI, and Health Infobase); and the Egyptian Ministry of Health and Population. Peer-reviewed literature on adult vaccination in Egypt was searched in PubMed and Google Scholar using the terms Egypt, vaccination, adults (including healthcare workers, older adults, and pregnant women), and coverage, uptake, recommendations, or policy (full strategy in Appendix C), limited to 2015-2026 and to English- and Arabic-language publications. Sources were included if they (a) were issued by a national or international health authority or published in a peer-reviewed journal, (b) addressed vaccination of adults, and (c) reported at least one of the four constructs defined below for a national population or a nationally

sampled group. Sources were excluded if they were news reports, non-peer-reviewed commentary, or single-facility studies without national relevance. Retrieval dates are recorded in the reference list and in Appendix C. Sources were screened and coded by two authors independently, with disagreements resolved by discussion.

Measures

DTP3 denotes receipt of three doses of a diphtheria-tetanus-pertussis-containing vaccine in the relevant infant cohort; MCV1 denotes the first dose of a measles-containing vaccine in the relevant child cohort.

Adult evidence was sorted into four constructs and kept apart throughout. This four-part framework was developed by the authors for this analysis and does not correspond to a single, previously validated external instrument. The four domains were chosen because they correspond to sequential, conceptually distinct stages between vaccine policy and documented population protection: whether a vaccine is formally recommended, whether a programme exists to deliver it, how many doses were supplied, and what proportion of a defined population is confirmed to have received it. Distinguishing these stages was necessary because the sources reviewed varied in which stage they actually reported, and collapsing them into a single category would have overstated what the underlying evidence showed. A recommendation is an official authority advising vaccination for an age or risk group: policy guidance, not receipt. Availability is a vaccine being offered through a program: capacity, not uptake. Uptake is a denominator-based measure of what people actually received, whether self-reported or administratively recorded. Distribution represents the doses supplied. It is a volume figure that becomes a coverage rate only when divided by a valid target population. Each domain was operationalized directly from the wording of the source reviewed for a given country and vaccine, rather than inferred: a source was coded as reporting a recommendation when an official immunization authority's guideline or schedule named the vaccine and target group without reporting delivery or receipt data; as availability when a national or subnational programme was described as delivering the vaccine regardless of reported uptake; as uptake when the source reported a percentage or proportion of a defined population that received the vaccine; and as distribution when the source reported a count of doses supplied or administered without an accompanying population denominator. Where a single source reported more than one of these categories for the same vaccine and country, each reported figure was coded separately under its corresponding domain. Adult policy breadth was assessed descriptively by listing, for each country, the vaccines and adult target groups named in the recommendations reviewed (Appendix D). These were not weighted, scored, or combined into an index, and no validated adult-policy breadth instrument was used.

Statistical analysis

For each country antigen-series, we summarized the data by calculating the mean, standard deviation (SD), minimum, maximum, and the value reported for 2024. Exploratory linear trends were estimated using ordinary least squares against calendar year, and using Newey-West standard errors with lag 1.

It is important to carefully interpret the estimates of trend. Newey-West standard errors (lag 1) were used because annual coverage within a country is serially correlated. Because Newey-West inference is asymptotic and each series contains only 10 annual observations, we repeated the analysis with t-based confidence intervals (8 degrees of freedom) and with conventional ordinary least squares standard errors, and adjusted the p-values of the six exploratory tests using the Holm method (Appendix E). Uncertainty related to subsequent WUENIC revisions, estimates, ecological confounding, and variations in reporting quality is not incorporated by the models. Coverage is bounded near 100%, so percentage-point trends can also mask differences in the proportion remaining unvaccinated.

The small number of purposively selected countries limits comparison across countries, not the description of change within a single country over time. Each trend estimate summarizes 10 annual observations for one country-antigen series, not three observations across countries; the regression is therefore a within-series descriptive tool, not a between-country comparative test, and should not be read as evidence that the three countries were sampled to support cross-country inference. Formal regression was used instead of a purely descriptive presentation (for example, reporting only the first and last observed values) because it uses all 10 annual points rather than the two endpoints, which reduces sensitivity to a single anomalous year, and it provides an explicit slope and interval that make the pace and precision of within-country change reportable and comparable across the six series. This added value is independent of the three-country limitation stated above, which concerns generalizability across countries rather than the validity of describing change within each country's own series.

To explore whether the selected time period influenced the results, we performed an additional post hoc analysis of the 2000-2024 DTP3 series for Egypt and Canada (data in Appendix A; results in Appendix F). The extended-window analysis was not conducted for US DTP3 or for the three MCV1 series. Conclusions from this post hoc analysis are therefore limited to these two DTP3 series and cannot be extended to the United States, to MCV1, or to time-window sensitivity in general.

Adult findings were summarized narratively and in structured tables. Comparable adult-uptake data were

not consistently available across the three countries, so we were not able to construct a cross-country uptake panel, impute missing values, or calculate an adult-policy breadth score.

Contextual extension

Information from 2025 to 2026 was included solely to provide background on vaccination programmes and policy context and was not treated as part of the 2015-2024 statistical endpoint.

Ethics, patient and public involvement, and sex and gender reporting

Ethics Approval

Formal ethics committee review was sought, and approval was received and documented as per the institutional policy of the Faculty of Medicine, Ain Shams University (approval no.: R224/2026).

Patient and Public Involvement

Patients and members of the public were not involved in the design, conduct, reporting, or dissemination of this analysis of aggregated public data.

Sex and Gender Reporting

The WUENIC estimates and adult sources used here were reported at the population level and were not consistently stratified by sex or gender. Sex- and gender-specific patterns therefore could not be analyzed, which limits the interpretation of population heterogeneity.

Results

Childhood immunization

As demonstrated in Table *1*, among the three selected countries, Egypt had the highest mean estimates for both antigens during 2015-2024. Appendix A summarises the annual estimates. The mean DTP3 coverage was 95.2% in Egypt, 94.1% in the United States, and 91.5% in Canada; mean MCV1 coverage was 94.9%, 91.6%, and 90.4%, respectively. In 2024, the corresponding DTP3 and MCV1 estimates were 97% and 97% for Egypt, 94% and 92% for the United States, and 92% and 92% for Canada [1,2]. These values describe the selected indicators and should not be interpreted as an overall ranking of immunization-system performance.

Indicator	Country	Mean	Range	2024	SD (pp)
DTP3	Egypt	95.2%	93-97%	97%	1.3
DTP3	United States	94.1%	93-95%	94%	0.6
DTP3	Canada	91.5%	91-92%	92%	0.5
MCV1	Egypt	94.9%	92-97%	97%	1.4
MCV1	United States	91.6%	90-92%	92%	0.7
MCV1	Canada	90.4%	89-92%	92%	1.2

TABLE 1: Childhood vaccination coverage in Egypt, United States, and Canada, 2015-2024

DTP3: third dose of diphtheria-tetanus-pertussis-containing vaccine; MCV1: first dose of measles-containing vaccine; SD: standard deviation; pp: percentage points; WUENIC: WHO/UNICEF Estimates of National Immunization Coverage

Values are the fixed WUENIC 2024 revision estimates (Appendices A and B) [1].

Although the difference in coverage expressed as percentage points was relatively small, the difference in the proportion remaining unvaccinated was larger: coverage of 92% leaves 8% unvaccinated, whereas coverage of 97% leaves 3%, a relative reduction of 62.5%. These figures are national-level estimates, however, and may change in later WUENIC revisions, and can conceal subnational pockets of under-immunization.

Exploratory childhood trends

Table 2 presents the exploratory linear trends for 2015-2024 (all values in percentage points per year). For DTP3, the estimated annual change was 0.364 in Egypt (95% CI, 0.277 to 0.450), -0.103 in the United States (95% CI, -0.200 to -0.007), and 0.152 in Canada (95% CI, 0.114 to 0.189). For MCV1, the corresponding estimates were 0.406 in Egypt (95% CI, 0.277 to 0.535), 0.036 in the United States (95% CI, -0.065 to 0.138), and 0.352 in Canada (95% CI, 0.281 to 0.422). The United States MCV1 interval includes both a small decrease and an increase. Because each model uses only 10 annual estimates, these slopes describe the selected analysis window and should not be interpreted as stable long-term trends.

Indicator	Country	Slope	95% CI	p-value	Holm-adjusted p	R^2
DTP3	Egypt	0.364	0.277 to 0.450	<0.001	<0.001	0.699
DTP3	United States	-0.103	-0.200 to -0.007	0.036	0.073	0.302
DTP3	Canada	0.152	0.114 to 0.189	<0.001	<0.001	0.758
MCV1	Egypt	0.406	0.277 to 0.535	<0.001	<0.001	0.720
MCV1	United States	0.036	-0.065 to 0.138	0.482	0.482	0.025
MCV1	Canada	0.352	0.281 to 0.422	<0.001	<0.001	0.822

TABLE 2: Exploratory childhood vaccination trend estimates in Egypt, United States, and Canada, 2015-2024

DTP3: third dose of diphtheria-tetanus-pertussis-containing vaccine; MCV1: first dose of measles-containing vaccine; CI: confidence interval; WUENIC: WHO/UNICEF Estimates of National Immunization Coverage

Slope: change in coverage, percentage points per year. Values are the fixed WUENIC 2024 revision estimates (Appendix A) [1]. Trends were estimated by ordinary least squares with Newey-West standard errors (lag 1). Estimates are exploratory: each series contains 10 annual observations, and p-values are shown unadjusted and after Holm adjustment for the six exploratory tests (Appendix E).

After Holm adjustment for six tests, the US DTP3 decline was no longer statistically significant (adjusted p=0.073); it was also not significant with t-based inference (p=0.070; 95% CI -0.217 to 0.011) or with conventional standard errors (p=0.100). All other significant trends remained significant under every approach (Holm-adjusted p<0.001) (Appendix E). Given the short series, the confidence intervals and p-values should be treated as exploratory rather than confirmatory.

Sensitivity of childhood trends to the analysis window

The DTP3 and MCV1 coverage across countries is further illustrated in Figures *1*-*2*. The period selected for analysis had an extensive effect on Egypt's exploratory DTP3 trend. For 2015-2024, coverage increased by an estimated 0.364 percentage points per year. However, when the analysis was extended back to 2000, the estimated trend changed to a decline of 0.132 percentage points annually. The analysis also clearly showed that the average coverage maintained by Egypt was 97.6% between 2000 and 2010. It reached 99% in 2001 before falling to 93% in 2012 and again in 2015. It then recovered to 97% in 2024. It can therefore be interpreted that the rise noticed during the latest decade reflected recovery from an earlier decline, although the linear slopes were simplified summaries of a trajectory that was not linear over time.

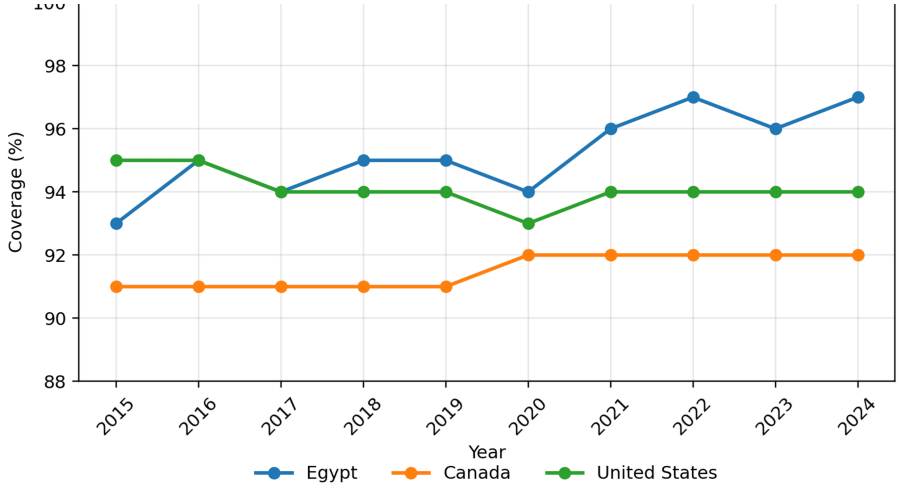


FIGURE 1: DTP3 coverage in Egypt, Canada, and the United States, 2015-2024

DTP3: third dose of diphtheria-tetanus-pertussis-containing vaccine

Coverage estimates are from the WHO/UNICEF Estimates of National Immunization Coverage (WUENIC), 2024 revision, restricted to 2015-2024 [1].

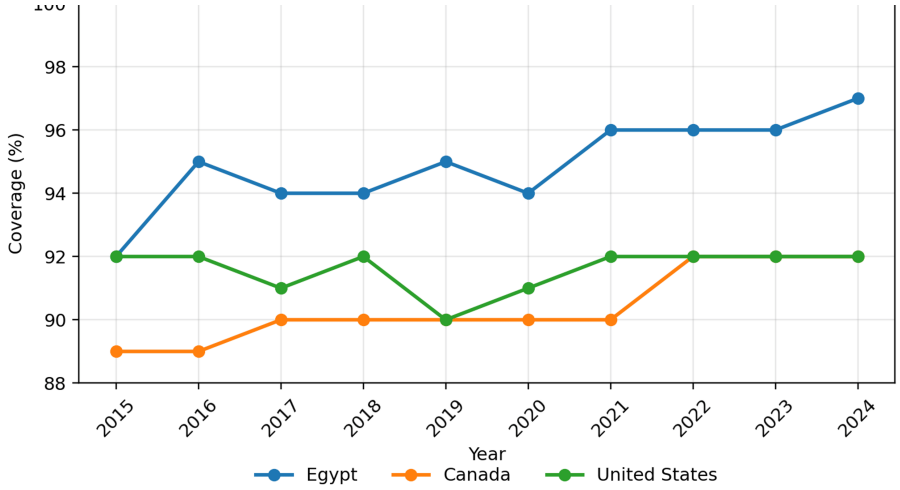


FIGURE 2: MCV1 coverage in Egypt, Canada, and the United States, 2015-2024

MCV1: first dose of measles-containing vaccine

Coverage estimates are from the WHO/UNICEF Estimates of National Immunization Coverage (WUENIC), 2024 revision, restricted to 2015-2024 [1].

Canada showed a similar but smaller difference between the two periods. DTP3 coverage was 95% in 2006, declined to 87% in 2011, and reached 92% in 2024. The estimated annual DTP3 slope was 0.059 percentage points during 2000-2024 (95% CI -0.037 to 0.155) and 0.152 during 2015-2024. Because this post hoc sensitivity analysis covered only Egypt and Canada DTP3, it should not be generalized to the US series or to MCV1 (Appendix F).

Adult vaccination policy breadth

The childhood coverage ordering did not align with the documented adult-policy landscape in these three cases. Official sources described extensive adult recommendations in Canada and the United States [4,6].

The reviewed US schedule included influenza, COVID-19, pneumococcal, RSV, herpes zoster, tetanus-diphtheria (Td)/tetanus-diphtheria-acellular pertussis (Tdap), hepatitis B, measles-mumps-rubella (MMR), varicella, human papillomavirus (HPV), and additional age- or risk-based vaccines [4]. Canadian NACI guidance covered many of the same domains, with implementation shaped by provincial and territorial arrangements [6].

Among the Egyptian sources reviewed, adult vaccination was described mainly for respiratory and risk-targeted indications, while nationally standardized uptake documentation was limited. This finding concerns the reviewed public documentation and does not prove that vaccination was unavailable or that no additional program or uptake data existed. Table *3* therefore compares evidence profiles rather than overall program quality or population protection. The documents reviewed and their coding under the four constructs are listed in Appendix D.

Country	Adult evidence profile	Supported interpretation	Sources
Egypt	Respiratory and risk-based adult vaccination guidance; adult uptake measured only for COVID-19 and in healthcare workers; no routine national uptake series identified.	Adult uptake cannot be compared nationally.	[2,3,8-10]
United States	CDC adult immunization schedule and national survey surveillance.	Recommendations and uptake are documented; early-season 2024 uptake varied across groups.	[4,5]
Canada	NACI guidance, provincial and territorial implementation, and national respiratory vaccination survey data.	Recommendations are documented; uptake data cover selected vaccines.	[6,7]

TABLE 3: The profile of adult vaccination evidence and supported interpretation by country

NACI: National Advisory Committee on Immunization (Canada); CDC: Centers for Disease Control and Prevention (United States)

Sources reviewed for each country and their coding are listed in Appendix D. The inability to identify a harmonized estimate in this targeted review reflects an evidence gap in the sources reviewed; it does not necessarily indicate an absence of vaccination or measurement.

Country-specific adult respiratory vaccination uptake indicators

The adult vaccination estimates presented below are intended to describe the situation within each individual country rather than enable direct comparisons between countries. The figures are based on different population denominators, age groups, survey methods, and reference periods and must not be interpreted as a comparative panel.

United States

CDC early-season estimates as of 9 November 2024 reported 34.7% influenza vaccination coverage and 17.9% coverage with the 2024-2025 COVID-19 vaccine among adults aged 18 years or older. RSV estimates were 39.7% among adults aged 75 years or older and 31.6% among adults aged 60-74 years at increased risk [5]. These estimates use different eligibility denominators.

Canada

The 2024-2025 Seasonal Respiratory Vaccination Coverage Survey reported influenza coverage of 33% among adults overall, 63% among adults aged 65 years or older, 32% among adults younger than 65 years with a chronic medical condition, and 22% among those younger than 65 years without a chronic medical condition. COVID-19 coverage was 54% among adults aged 65 years or older [7]. The survey design and observation window differ from the US estimates.

Egypt

Apart from COVID-19 coverage data [3,9] and a study of healthcare workers [10], no harmonized national series of routine adult uptake for influenza, pneumococcal, or RSV vaccination was identified among the sources reviewed. Because the search was not systematic and may not capture all national, subnational, or Arabic-language sources, this should be reported as a documentation gap within the reviewed evidence rather than proof that no national estimate exists.

Comparison of the three adult priority frameworks

On observing the relevant data sources, it was observed that recurring adult policy domains included influenza, COVID-19, pneumococcal vaccination, and Td/Tdap-type boosters, although eligibility and delivery differed across countries and populations. Zoster, RSV, and hepatitis B recommendations varied more strongly by age, risk, and program design. Table *4* shows a qualitative comparison across the studied countries due to the unavailability of a harmonized schedule of uptake to compare.

Vaccine domain	Egypt	Canada	United States
Influenza	Targeted/risk-based use	Broad seasonal programme	Broad seasonal recommendation
COVID-19	Policy-dependent booster doses	Risk/age-based guidance	Age/risk-based schedule
Pneumococcal	Risk-based use; national programme breadth not established	adult guidance	Age/risk-based recommendations
Td/Tdap	Booster/risk-based use	Routine adult booster guidance	Routine adult booster/pregnancy guidance
Zoster	No broad national recommendation	older-adult/immunocompromised guidance	Age/immunocompromised-adult guidance
RSV	Evidence incomplete	Older-adult/high-risk guidance	Older-adult/pregnancy/risk-based guidance
Hepatitis B	Risk-based relevance described	Risk-based guidance	Broad adult recommendation through age 59 + risk-based options

TABLE 4: Comparative adult vaccination priority framework by vaccine domain and country (author synthesized based on reviewed sources)

Td/Tdap: tetanus-diphtheria/tetanus-diphtheria-acellular pertussis; RSV: respiratory syncytial virus

This framework is qualitative, and it summarizes what was found in the reviewed official sources. It, however, does not represent a measure of standardized vaccine uptake nor prove the absence of unlisted recommendations or programmes. Eligibility and delivery differ by country.

Discussion

We purposively selected three countries and reviewed their published data in order to find out whether their listed childhood coverage rates aligned with the corresponding documented adult policy landscape. They did not align: Egypt had the highest mean DTP3 and MCV1 coverage, whereas the reviewed Canadian and US sources documented broader adult recommendation frameworks. No prediction, correlation, or inverse relationship can be demonstrated based on this descriptive contrast.

Childhood vaccination is commonly organized around a defined birth cohort, scheduled doses, and established delivery and reporting systems. Adult vaccination spans different ages, medical risks, and vaccines. Its delivery may involve several providers and funding arrangements, while recommendations, programme availability, and measured uptake are distinct indicators. Consequently, a country's childhood coverage estimate cannot, by itself, indicate the breadth or implementation of its adult immunization programme.

These distinctions help interpret the three countries reviewed here. Canada has national advisory guidance, but provinces and territories design and deliver immunization programmes, so a national recommendation need not imply uniform implementation. The United States has a consolidated adult vaccination schedule and surveillance for selected vaccines, yet uptake can differ across populations. For Egypt, the targeted sources yielded less harmonized national adult uptake documentation [8-10]; this reflects a limitation of the evidence available for this review rather than evidence that adult vaccination or additional data are absent. These structural and measurement differences are plausible explanations for the descriptive contrast observed. This study did not test their causal effects.

Childhood coverage indicators describe important components of routine immunization but do not summarize life-course policy, implementation, or uptake. We managed to report both childhood coverage and adult evidence as separate dimensions in order to reduce the risk of treating one available indicator as a measure of the whole immunization system.

The Egypt DTP3 result also illustrates window sensitivity. The 2015-2024 trend was positive, while that of 2000-2024 was negative because coverage had been higher during part of the earlier period. Both trends describe their selected windows, but neither fully captures the non-linear trajectory. The Canada DTP3 trend was also attenuated in the longer window. Because the extended analysis was limited to two DTP3 series, it should be regarded as a methodological caution and not be interpreted as a general conclusion about all childhood trends.

In order to prevent the mix-up of data or unnecessary confusion, we created a four-construct framework formed of distinct categories of policy recommendation, program availability, measured uptake, and dose distribution. The reviewed sources do not establish that Egypt has a weak adult platform; they show that the publicly reviewed documentation was less complete and more selectively risk-targeted than the Canadian and US documentation. Accordingly, policy decisions should be made cautiously when important gaps remain in program information or documentation. In the Eastern Mediterranean Region, such decisions are informed by national immunization technical advisory groups [11].

For Canada and the United States, the scope of vaccination recommendations, actual program delivery, and resulting population protection should be considered as separate dimensions. This is because their broad recommendations do not guarantee high or equitable uptake of vaccines.

COVID-19 vaccination data [3,9] do not, on its own, represent the full scope of adult immunization policy or program implementation. Adult vaccination programs may also cover influenza, pneumococcal disease, Td/Tdap, zoster, RSV, hepatitis B, and other age- or additional vaccines recommended according to individual risk. National vaccination priorities differ according to disease burden, population structure, financing, delivery infrastructure, and the reach of eligible groups.

Finally, apart from COVID-19 coverage data [3,9] and studies of specific groups such as healthcare workers [10], we did not identify a standardized national series of routine adult vaccine uptake in Egypt. Confirming whether such data exist will require a systematic multilingual search and consultation with national data holders, which future life-course vaccination policy analyses could undertake to strengthen conclusions through more comparable adult-immunization measurement across income settings.

Limitations

The three studied countries, which were deliberately selected for comparison, cannot be generalized to other countries or income groups, and their selection also prevents inference about prediction or association between childhood coverage and adult-policy breadth.

We used a fixed extraction of the WUENIC 2024 revision. Because WUENIC estimates are revised annually, later releases may change historical values, means, and coefficients; we did not quantify how much these would change.

The trend models contain only ten annual observations per series, and Newey-West inference is approximate at this sample size. P-values were therefore treated as exploratory and were also reported after Holm adjustment for six tests (Appendix E); after adjustment, the US DTP3 decline was no longer statistically significant. Vaccination coverage is also close to the upper limit of 100%, meaning that linear trends expressed in percentage-point slopes may not fully capture meaningful changes in the population remaining unvaccinated. Because this post hoc analysis covered only Egypt and Canada DTP3, it serves as a methodological caution and does not support conclusions about time-window sensitivity for other countries or for MCV1.

Adult vaccination data could not be combined into a consistent cross-country dataset. Estimates from Canada and the United States varied in their reporting periods, population denominators, age band, and method, and no comparable Egyptian national estimate was found in the targeted official-source review. Our search was neither systematic nor exhaustive (Appendix C), particularly for Arabic-language and subnational sources. Recommendation, availability, uptake, and distribution measure different stages and were not treated as equivalent.

National averages can mask subnational inequality, differences in access and vaccine confidence, health-system fragmentation, and variation in reporting quality. WUENIC estimates represent modeled adjustment and contextual review, and are not direct survey measurements.

The four-construct framework describes what the reviewed sources document; it does not rank countries or recommend that any country adopt a particular vaccine package.

Conclusions

During the period between 2015 and 2024, Egypt recorded the highest average WUENIC estimates for DTP3 and MCV1, while Canada and the US had broader adult recommendation frameworks. No standardized

Egyptian national adult-uptake vaccination series was found in the official sources we reviewed. Therefore, these findings describe selected indicators and documentation that may not be able to confirm specific rankings. The post hoc Egypt and Canada DTP3 analyses also showed that slope magnitude and, for Egypt, direction depended on the selected time window. For more reliable comparisons, assessments should report childhood coverage, adult recommendations, programme availability, measured uptake, and dose distribution separately. In order to be able to provide broader conclusions, a larger country sample, a reproducible adult-policy measure, a systematic multilingual source search, and complete sensitivity analyses are needed. Future studies should evaluate a larger and systematically selected sample of countries using standardized adult vaccination indicators to improve external validity and permit more robust international comparisons.

Appendices

Appendix A

Country	ISO3	Indicator	WHO GHO code	Year	Coverage (%)	WUENIC revision	Used in
Egypt	EGY	DTP3	WHS4_100	2015	93	2024 revision	Main analysis (Tables 1-2)
Egypt	EGY	DTP3	WHS4_100	2016	95	2024 revision	Main analysis (Tables 1-2)
Egypt	EGY	DTP3	WHS4_100	2017	94	2024 revision	Main analysis (Tables 1-2)
Egypt	EGY	DTP3	WHS4_100	2018	95	2024 revision	Main analysis (Tables 1-2)
Egypt	EGY	DTP3	WHS4_100	2019	95	2024 revision	Main analysis (Tables 1-2)
Egypt	EGY	DTP3	WHS4_100	2020	94	2024 revision	Main analysis (Tables 1-2)
Egypt	EGY	DTP3	WHS4_100	2021	96	2024 revision	Main analysis (Tables 1-2)
Egypt	EGY	DTP3	WHS4_100	2022	97	2024 revision	Main analysis (Tables 1-2)
Egypt	EGY	DTP3	WHS4_100	2023	96	2024 revision	Main analysis (Tables 1-2)
Egypt	EGY	DTP3	WHS4_100	2024	97	2024 revision	Main analysis (Tables 1-2)
Canada	CAN	DTP3	WHS4_100	2015	91	2024 revision	Main analysis (Tables 1-2)
Canada	CAN	DTP3	WHS4_100	2016	91	2024 revision	Main analysis (Tables 1-2)
Canada	CAN	DTP3	WHS4_100	2017	91	2024 revision	Main analysis (Tables 1-2)
Canada	CAN	DTP3	WHS4_100	2018	91	2024 revision	Main analysis (Tables 1-2)
Canada	CAN	DTP3	WHS4_100	2019	91	2024 revision	Main analysis (Tables 1-2)
Canada	CAN	DTP3	WHS4_100	2020	92	2024 revision	Main analysis (Tables 1-2)
Canada	CAN	DTP3	WHS4_100	2021	92	2024 revision	Main analysis (Tables 1-2)
Canada	CAN	DTP3	WHS4_100	2022	92	2024 revision	Main analysis (Tables 1-2)
Canada	CAN	DTP3	WHS4_100	2023	92	2024 revision	Main analysis (Tables 1-2)
Canada	CAN	DTP3	WHS4_100	2024	92	2024 revision	Main analysis (Tables 1-2)
United States	USA	DTP3	WHS4_100	2015	95	2024 revision	Main analysis (Tables 1-2)
United States	USA	DTP3	WHS4_100	2016	95	2024 revision	Main analysis (Tables 1-2)
United States	USA	DTP3	WHS4_100	2017	94	2024 revision	Main analysis (Tables 1-2)
United States	USA	DTP3	WHS4_100	2018	94	2024 revision	Main analysis (Tables 1-2)
United States	USA	DTP3	WHS4_100	2019	94	2024 revision	Main analysis (Tables 1-2)
United States	USA	DTP3	WHS4_100	2020	93	2024 revision	Main analysis (Tables 1-2)
United States	USA	DTP3	WHS4_100	2021	94	2024 revision	Main analysis (Tables 1-2)
United States	USA	DTP3	WHS4_100	2022	94	2024 revision	Main analysis (Tables 1-2)
United States	USA	DTP3	WHS4_100	2023	94	2024 revision	Main analysis (Tables 1-2)
United States	USA	DTP3	WHS4_100	2024	94	2024 revision	Main analysis (Tables 1-2)

Egypt	EGY	MCV1	WHS8_110	2015	92	2024 revision	Main analysis (Tables 1-2)
Egypt	EGY	MCV1	WHS8_110	2016	95	2024 revision	Main analysis (Tables 1-2)
Egypt	EGY	MCV1	WHS8_110	2017	94	2024 revision	Main analysis (Tables 1-2)
Egypt	EGY	MCV1	WHS8_110	2018	94	2024 revision	Main analysis (Tables 1-2)
Egypt	EGY	MCV1	WHS8_110	2019	95	2024 revision	Main analysis (Tables 1-2)
Egypt	EGY	MCV1	WHS8_110	2020	94	2024 revision	Main analysis (Tables 1-2)
Egypt	EGY	MCV1	WHS8_110	2021	96	2024 revision	Main analysis (Tables 1-2)
Egypt	EGY	MCV1	WHS8_110	2022	96	2024 revision	Main analysis (Tables 1-2)
Egypt	EGY	MCV1	WHS8_110	2023	96	2024 revision	Main analysis (Tables 1-2)
Egypt	EGY	MCV1	WHS8_110	2024	97	2024 revision	Main analysis (Tables 1-2)
Canada	CAN	MCV1	WHS8_110	2015	89	2024 revision	Main analysis (Tables 1-2)
Canada	CAN	MCV1	WHS8_110	2016	89	2024 revision	Main analysis (Tables 1-2)
Canada	CAN	MCV1	WHS8_110	2017	90	2024 revision	Main analysis (Tables 1-2)
Canada	CAN	MCV1	WHS8_110	2018	90	2024 revision	Main analysis (Tables 1-2)
Canada	CAN	MCV1	WHS8_110	2019	90	2024 revision	Main analysis (Tables 1-2)
Canada	CAN	MCV1	WHS8_110	2020	90	2024 revision	Main analysis (Tables 1-2)
Canada	CAN	MCV1	WHS8_110	2021	90	2024 revision	Main analysis (Tables 1-2)
Canada	CAN	MCV1	WHS8_110	2022	92	2024 revision	Main analysis (Tables 1-2)
Canada	CAN	MCV1	WHS8_110	2023	92	2024 revision	Main analysis (Tables 1-2)
Canada	CAN	MCV1	WHS8_110	2024	92	2024 revision	Main analysis (Tables 1-2)
United States	USA	MCV1	WHS8_110	2015	92	2024 revision	Main analysis (Tables 1-2)
United States	USA	MCV1	WHS8_110	2016	92	2024 revision	Main analysis (Tables 1-2)
United States	USA	MCV1	WHS8_110	2017	91	2024 revision	Main analysis (Tables 1-2)
United States	USA	MCV1	WHS8_110	2018	92	2024 revision	Main analysis (Tables 1-2)
United States	USA	MCV1	WHS8_110	2019	90	2024 revision	Main analysis (Tables 1-2)
United States	USA	MCV1	WHS8_110	2020	91	2024 revision	Main analysis (Tables 1-2)
United States	USA	MCV1	WHS8_110	2021	92	2024 revision	Main analysis (Tables 1-2)
United States	USA	MCV1	WHS8_110	2022	92	2024 revision	Main analysis (Tables 1-2)
United States	USA	MCV1	WHS8_110	2023	92	2024 revision	Main analysis (Tables 1-2)
United States	USA	MCV1	WHS8_110	2024	92	2024 revision	Main analysis (Tables 1-2)
Egypt	EGY	DTP3	WHS4_100	2000	98	2024 revision	Post hoc extended window only
Egypt	EGY	DTP3	WHS4_100	2001	99	2024 revision	Post hoc extended window only
Egypt	EGY	DTP3	WHS4_100	2002	97	2024 revision	Post hoc extended window only
Egypt	EGY	DTP3	WHS4_100	2003	98	2024 revision	Post hoc extended window only
Egypt	EGY	DTP3	WHS4_100	2004	97	2024 revision	Post hoc extended window only
Egypt	EGY	DTP3	WHS4_100	2005	98	2024 revision	Post hoc extended window only
Egypt	EGY	DTP3	WHS4_100	2006	98	2024 revision	Post hoc extended window only
Egypt	EGY	DTP3	WHS4_100	2007	98	2024 revision	Post hoc extended window only
Egypt	EGY	DTP3	WHS4_100	2008	97	2024 revision	Post hoc extended window only

Egypt	EGY	DTP3	WHS4_100	2009	97	2024 revision	Post hoc extended window only
Egypt	EGY	DTP3	WHS4_100	2010	97	2024 revision	Post hoc extended window only
Egypt	EGY	DTP3	WHS4_100	2011	96	2024 revision	Post hoc extended window only
Egypt	EGY	DTP3	WHS4_100	2012	93	2024 revision	Post hoc extended window only
Egypt	EGY	DTP3	WHS4_100	2013	97	2024 revision	Post hoc extended window only
Egypt	EGY	DTP3	WHS4_100	2014	94	2024 revision	Post hoc extended window only
Canada	CAN	DTP3	WHS4_100	2000	89	2024 revision	Post hoc extended window only
Canada	CAN	DTP3	WHS4_100	2001	89	2024 revision	Post hoc extended window only
Canada	CAN	DTP3	WHS4_100	2002	88	2024 revision	Post hoc extended window only
Canada	CAN	DTP3	WHS4_100	2003	91	2024 revision	Post hoc extended window only
Canada	CAN	DTP3	WHS4_100	2004	91	2024 revision	Post hoc extended window only
Canada	CAN	DTP3	WHS4_100	2005	93	2024 revision	Post hoc extended window only
Canada	CAN	DTP3	WHS4_100	2006	95	2024 revision	Post hoc extended window only
Canada	CAN	DTP3	WHS4_100	2007	94	2024 revision	Post hoc extended window only
Canada	CAN	DTP3	WHS4_100	2008	92	2024 revision	Post hoc extended window only
Canada	CAN	DTP3	WHS4_100	2009	91	2024 revision	Post hoc extended window only
Canada	CAN	DTP3	WHS4_100	2010	89	2024 revision	Post hoc extended window only
Canada	CAN	DTP3	WHS4_100	2011	87	2024 revision	Post hoc extended window only
Canada	CAN	DTP3	WHS4_100	2012	91	2024 revision	Post hoc extended window only
Canada	CAN	DTP3	WHS4_100	2013	91	2024 revision	Post hoc extended window only
Canada	CAN	DTP3	WHS4_100	2014	91	2024 revision	Post hoc extended window only

TABLE 5: Annual WUENIC coverage estimates (%), 2024 revision

WUENIC: WHO/UNICEF Estimates of National Immunization Coverage

Source: WHO/UNICEF WUENIC 2024 revision (completed 15 July 2025) [1]; WHO Global Health Observatory indicators WHS4_100 (DTP3) and WHS8_110 (MCV1) [12].

Appendix B

Indicator	Country	Mean (%)	SD (pp)	Minimum (%)	Maximum (%)	2024 (%)
DTP3	Egypt	95.2	1.3	93	97	97
DTP3	United States	94.1	0.6	93	95	94
DTP3	Canada	91.5	0.5	91	92	92
MCV1	Egypt	94.9	1.4	92	97	97
MCV1	United States	91.6	0.7	90	92	92
MCV1	Canada	90.4	1.2	89	92	92

TABLE 6: Descriptive statistics, 2015-2024 (computed by formula from Appendix A)

This table reproduces the data presented in Table 1 of the current article.

Appendix C

#	Source searched	URL/database	Search terms or navigation path	Date searched	Records identified	Records included
1	WHO Immunization Data portal	https://immunizationdata.who.int/	Vaccination Coverage section → filtered by country (Egypt, Canada, United States) → antigen (DTP3, MCV1)	21 Feb 2026	N/A - data portal, not a literature database	Coverage series extracted directly (three countries × two antigens)
2	WHO COVID-19 vaccination dashboard	https://data.who.int/dashboards/covid19/vaccines	Vaccines tab → filtered by country (Egypt, Canada, United States)	21 Feb 2026	N/A - dashboard, not a literature database	Coverage figures extracted directly
3	US CDC adult immunization schedule	https://www.cdc.gov/vaccines/hcp/imz-schedules/adult.html	Direct navigation to 2025 Recommended Adult Immunization Schedule (Table 1: By Age; Table 2: By Medical Condition)	03 Mar 2026	N/A - official schedule document	Schedule document used directly
4	US CDC MMWR	https://www.cdc.gov/mmwr/	Browsed MMWR by topic ("Influenza," "RSV") and Recommendations and Reports	03 Mar 2026	N/A - browsed by topic	One report used [5]
5	Canadian Immunization Guide and NACI statements	https://www.canada.ca/en/public-health/services/canadian-immunization-guide.html	Guide homepage → Part 3: Vaccination of Specific Populations → Immunization of Adults	27 Feb 2026	N/A - official guideline	Guidance used directly
6	PHAC Health Infobase - Seasonal Respiratory Vaccination Coverage Survey	https://health-infobase.canada.ca/vaccination/seasonal-respiratory-vaccination-coverage-survey/	health-infobase.canada.ca → Vaccination → Seasonal Respiratory Vaccination Coverage Survey → report.html (2024–2025 report)	03 Mar 2026	N/A - official survey report	Report used directly
7	Egyptian Ministry of Health and Population website	https://www.mohp.gov.eg/	site:mohp.gov.eg تطعيمات البالغين; cross-verified official statement via SIS.gov.eg and elwatannews.com	03 Mar 2026	One citable aggregate figure (official statement)	-
8	Peer-reviewed literature on adult vaccination in Egypt	PubMed/Google Scholar	"adult vaccination Egypt coverage," "Egypt COVID-19 vaccination coverage," "influenza vaccination coverage Egypt"	03 Mar 2026	Five distinct peer-reviewed records	-

TABLE 7: Search log for adult-vaccination sources

References [1-10]

Appendix D

Country	Document	Issuing body/authors	Year	Type	Retrieval date	Vaccines and adult groups named	Recommendation	Availability	Uptake	Distribution	Notes
Egypt; Canada; United States	WHO Immunization Data portal: vaccination schedules, vaccine introductions, coverage	World Health Organization	2025	Official data portal	21 Feb 2026	Country-reported (JRF) schedules incl. adolescent/adult doses	Yes (JRF-reported schedule)	Yes (vaccine introductions)	No (childhood coverage only)	No	Schedule data are country-reported via the WHO/UNICEF Joint Reporting Form.
Egypt; Canada; United States	COVID-19 vaccination dashboard	World Health Organization	2025	Official data portal	21 Feb 2026	COVID-19 vaccines; total population and adult groups	No	No	Yes (COVID-19 coverage)	Yes	Only COVID-19; not representative of routine adult vaccination.
United States	Recommended adult immunization schedule for ages 19 years or older, United States, 2025	Centers for Disease Control and Prevention	2025	Official schedule	3 Mar 2026	Influenza, COVID-19, RSV, Td/Tdap, MMR, varicella, zoster, HPV, pneumococcal, hepatitis A/B, meningococcal, Hib, mpox; by age and risk group	Yes	No	No	No	-
United States	Influenza, COVID-19, and RSV vaccination coverage among adults — United States, fall 2024 (MMWR 2024;73:1044–51)	Kriss JL, Black CL, Razzaghi H, et al.	2024	Surveillance report	1 June 2025	Influenza and COVID-19 (adults ≥18 y); RSV (adults ≥60 y at risk and ≥75 y)	Yes (JRF-reported schedule)	Yes (vaccine introductions)	No (childhood coverage only)	No	Covers early 2024–25 season only (to week ending 9 Nov 2024).
Canada	Canadian Immunization Guide and NACI adult immunization recommendations	Public Health Agency of Canada	2025	Official guideline	27 Feb 2026	Adult routine and risk-based vaccines (influenza, pneumococcal, zoster, Td/Tdap, RSV, COVID-19, others)	Yes (JRF-reported schedule)	Yes (vaccine introductions)	No (childhood coverage only)	No	Implementation varies by province/territory.
Canada	Seasonal Respiratory Vaccination Coverage Survey, 2024–2025	Public Health Agency of Canada	2025	National survey	1 June 2025	Seasonal respiratory vaccines in adults (e.g., influenza, COVID-19, RSV)	Yes (JRF-reported schedule)	Yes (vaccine introductions)	No (childhood coverage only)	No	Confirm vaccines and age groups reported in the edition cited.
Egypt	Adult vaccination against respiratory infections in Egypt: a review of expert opinions	Madkour A, Elsayed AM, Sweed H, El Ebrashy I, Abdelhamid M, Zidan M	2024	Expert-opinion review	1 June 2025	Influenza, pneumococcal, COVID-19 and other respiratory vaccines for high-risk adults	Yes (JRF-reported schedule)	Yes (vaccine introductions)	No (childhood coverage only)	No	Expert consensus, not an official policy document; does not meet the official-authority criterion on its own.
Egypt	COVID-19 vaccination coverage in Egypt: a large-scale national survey - to help achieve vaccination target, March-May, 2022	Kandeel A, Eldeyahy I, Abu ElSood H, et al. (Ministry of Health and Population)	2023	National household survey	1 June 2025	COVID-19; adults ≥18 y, all 27 governorates	Yes (JRF-reported schedule)	Yes (vaccine introductions)	No (childhood coverage only)	No	One-off COVID-19 survey; not a routine adult-uptake series.
Egypt	Attitudes, beliefs and practice of Egyptian healthcare workers towards seasonal influenza vaccination	Hakim SA, Amin W, Allam MF, Fathy AM, Mohsen A	2021	Cross-sectional study	1 June 2025	Seasonal influenza; healthcare workers (physicians, nurses)	Yes (JRF-reported schedule)	Yes (vaccine introductions)	No (childhood coverage only)	No	Occupational subgroup; not a national adult estimate.

TABLE 8: Documents reviewed and construct coding

References [2-10]

Appendix E

Indicator	Country	Slope	Primary 95% CI	Primary p	Holm-adjusted p	t(8)-based 95% CI	t(8)-based p	OLS SE 95% CI	OLS SE p	R^2
DTP3	Egypt	0.364	0.277 to 0.450	<0.001	<0.001	0.262 to 0.465	<0.001	0.169 to 0.558	0.003	0.699
DTP3	United States	-0.103	-0.200 to -0.007	0.036	0.073	-0.217 to 0.011	0.070	-0.231 to 0.025	0.100	0.302
DTP3	Canada	0.152	0.114 to 0.189	<0.001	<0.001	0.107 to 0.196	<0.001	0.082 to 0.221	0.001	0.758
MCV1	Egypt	0.406	0.277 to 0.535	<0.001	<0.001	0.254 to 0.558	<0.001	0.199 to 0.613	0.002	0.720
MCV1	United States	0.036	-0.065 to 0.138	0.482	0.482	-0.083 to 0.156	0.502	-0.150 to 0.222	0.664	0.025
MCV1	Canada	0.352	0.281 to 0.422	<0.001	<0.001	0.269 to 0.434	<0.001	0.218 to 0.485	<0.001	0.822

TABLE 9: Exploratory trend estimates with sensitivity analyses, 2015-2024

Slope: change in coverage, percentage points per year. Primary: ordinary least squares (OLS) with Newey-West SE (lag 1), normal-based 95% CI (as in Table 2 of the current article).

Holm adjustment applied across the six 2015-2024 tests. t(8)-based intervals use the Newey-West SE with 8 degrees of freedom instead of the normal approximation. OLS SE: conventional (non-HAC) standard errors.

The US DTP3 decline was significant only under the primary analysis (p=0.036). It was not significant after Holm adjustment (p=0.073), with t-based inference (p=0.070; CI includes zero), or with conventional SEs (p=0.100). All other significant trends remained so under every approach.

Appendix F

Extended window (post hoc), DTP3, 2000-2024					
Indicator	Country	Slope	95% CI	p	R^2
DTP3	Egypt	-0.132	-0.213 to -0.050	0.002	0.328
DTP3	Canada	0.059	-0.037 to 0.155	0.227	0.063

TABLE 10: Extended window (post hoc), DTP3, 2000-2024

Post hoc analysis limited to Egypt and Canada DTP3. Slope: change in coverage, percentage points per year. Ordinary least squares with Newey-West standard errors (lag 1).

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Institutional Review Board, Faculty of Medicine, Ain Shams University issued approval R224/2026. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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Nada R. Sayed and Nour R. Sayed participated equally in this work. No AI tools were used in the preparation of this manuscript. Claude AI (Anthropic, San Francisco, California, USA) was only used for help with brainstorming. The research idea, the actual data, the vaccination coverage figures, the statistical analysis, the editing, and scientific claims are all our team's own work.

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