

Stephen Protheroe-Hewitt Coursework - Submission

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Geographical Information Systems
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Geodemographic Analysis Using GIS
Software

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Data and Information Systems

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Abstract

Geographical information systems (GIS) allow users to work with accumulated data to store, investigate and analyse, allowing users the ability to present this in the most appropriate way. There have been many uses of GIS in assorted studies, from creating thematic mapping for groundwater resources and groundwater recharge sites for planning and management, to providing cheaper decision-making tools in developing countries.

The measles, mumps and rubella (MMR) vaccination was introduced in 1988 and saw incidences dropping to low levels but following a discredited study in 1998 linking the MMR vaccine to autism, the MMR vaccine uptake began to decline, and measles cases began to rise, culminating in a measles outbreak within Swansea between November 2012 and July 2013.

This report investigates why measles became prevalent in Wales between 2012/13 and 2022/23, the hypotheses being examined, and the data retrieved from various sources for analysis and interpretation within MapInfo to find any potential patterns and trends, with the report providing a conclusion and any recommendations from the findings, as well as future research ideas.

Introduction

Geographical information systems (GIS) allow users to work with accumulated data via spatial and vector geographical information to store, investigate, analyse, and present in the most appropriate way by thematic maps and different layers [1]. GIS are used in various studies, from usage in creating thematic mapping for groundwater resources and recharge sites in water resource planning and management in Ethiopia [2], to combining Google Earth usage with GIS data and Global Positioning System (GPS) tracking, providing inexpensive decision-making tools in developing countries, like urban household surveys within Cameroon [3].

The measles vaccination was introduced in 1968, with the measles, mumps, and rubella (MMR) vaccination introduced in 1988 to remarkable success, with incidences dropping to extremely low levels. Following a discredited study in 1998 linking the MMR vaccine to autism and subsequent media coverage, the MMR vaccine uptake began to decline, and measles cases rose [4]. This continual decline in Wales resulted in a measles outbreak in Swansea in November 2012, resulting in over 1,200 people becoming ill [5].

This report investigates why measles became prevalent within Wales between 2012/13 and 2022/23, the hypothesis to be examined, and the data retrieval for analysis and interpretation within MapInfo (a GIS used to upload, analyse, and interpret spatial data [6]) to find any patterns and trends. The report concludes with any recommendations from the findings, with future research ideas. While data can be manipulated to form narratives, data must be analysed and interpreted logically to produce meaningful findings and conclusions to assist with informed decision-making.

Hypothesis

This analysis focuses on two areas that could affect the reduction in MMR uptake in Wales. These areas are as follows:

- Deprivation
- Disproportion of ethnic groups

Deprivation is classed as relative socioeconomic status and income between others within different social groups, where income and health inequalities can lead to higher mortality rates [7]. In England and Wales, the Index of Multiple Deprivation (IMD) is used to measure deprivation in areas like income and employment, with lower scores indicating higher deprivation [8]. This is used with the Townsend Deprivation Index (TDI), which measures material deprivation by unemployment, home ownership, car ownership, and household overcrowding [9]. As deprivation is linked to poorer health and conditions, there could be a link that the more deprived people are, the lower the MMR vaccination uptake.

During the beginning of the coronavirus pandemic, reports emerged that ethnic minority groups were at higher risk of dying after contracting the virus. According to Platt [10], April 2020 hospital admissions showed evidence of higher mortality rates among black and Asian patients, while May 2020 evidenced almost all ethnic minority groups having a higher fatality risk compared to white British of similar age. This was further evidenced in a Public Health England report of coronavirus deaths, whereby Bangladeshi's had twice the risk of death, with Chinese, Caribbean, and other Asian and black ethnicities between 10% to 50% at higher risk of death [11]. Due to these reported health inequalities between ethnic minority groups and white British, there could be reduced MMR uptake within ethnic minority groups.

As a result, the hypothesis of this report is:

1. H_0 (Null hypothesis) = There are no significant patterns or trends between deprivation, ethnic minority groups, and the MMR uptake
2. H_1 or H_a (Alternative Hypothesis) = There are significant patterns or trends between deprivation, ethnic minority groups, and the MMR uptake

Methodology

The methodology describes the datasets required to analyse the data and determine whether the hypothesis is proven, allowing for informed results and recommendations on how to improve the MMR uptake.

The required data is as follows:

- Local/Unitary authority boundary data from UK Data Service (data management service providing high volumes of collated social and population data in the UK [12]) – This provides a breakdown by local authority for improved clarity and visualisation, providing the breakdown of MMR coverage via thematic mapping like how coronavirus deaths were recorded by Public Health Wales (PHW) during the pandemic [13].
- MMR coverage immunisation data from Health Map Wales (a tool providing health data in Wales like life expectancy and hospital admissions [14]) – This provides a breakdown of MMR coverage data and is the required raw data for the analysis of MMR coverage. It has been retrieved via local authority between 2015/16 and 2021/22. Below is an extract of data retrieved for 'MMR coverage (1 dose) by age 16 (% uptake)' by local authorities.

LOCAL AUTHORITY	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
Isle of Anglesey	95.1	94.3	92.1	96.3	95	94.7	96.8
Gwynedd	94.5	95.7	94.3	95.6	97.2	96.5	97
Conwy	93	92	91.8	94	96	94.2	94.3
Denbighshire	91.5	92.1	89.6	90.8	93.5	94.1	95
Flintshire	95.5	94.6	94.2	95.7	96.4	95.5	94.8
Wrexham	96.4	95.1	95.5	96.9	95	96.8	96.5
Ceredigion	94.5	93	92.6	95.3	94.7	94.6	95.3
Pembrokeshire	93.2	92.5	92.5	93.9	94.8	95.1	94.7
Carmarthenshire	93.8	92.6	91.7	93.8	93.6	94.8	93.1
Swansea	94.6	91.5	91.8	91.8	93.8	93.6	94.6
Neath Port Talbot	96.3	94.6	92.4	96.2	95.6	95.5	96.5
Bridgend	96.3	96	94.2	93.6	95.4	95.6	95.5
Vale of Glamorgan	93.4	94.5	92.2	94.5	94.8	94.5	94.9
Cardiff	92.4	91.5	90.7	90.6	92.4	92.4	93.6
Rhondda Cynon Taf	96.6	95.7	94.4	95.5	95.3	95.9	95.9
Caerphilly	97.8	97	96.3	96.6	97.2	97.3	97.6
Blaenau Gwent	96.7	95.1	94	96.8	97.4	98	97
Torfaen	97.8	95.4	96.4	95.9	97	97.2	96.9
Monmouthshire	90.4	86.7	84.6	91.2	92	93.8	91.7
Newport	94.4	91.6	93.3	94.7	92.9	94.5	94.4
Powys	92.1	89.1	90.1	93.3	93.3	93	91.5
Merthyr Tydfil	95.6	96.4	93.8	93.3	93.6	96	94.5

Fig. 1 Health Map Wales® Extract of 1st dose MMR Coverage by Local Authority

- Older and newer MMR uptake immunisation data from Stats Wales (free service allowing users to view and manipulate Welsh data [15]) and PHW – Stats Wales provide extra MMR coverage data before 2015/16, with PHW providing the most recent complete figures for 2022/23, allowing further analysis to cover the required period with a complete dataset. Below is an extract of data retrieved for ‘MMR 2nd dose by age 16 (% uptake)’ for the periods 2012/13, 2013/14, 2014/15, and 2022/23 by local authorities, forming a complete dataset.

LOCAL AUTHORITY	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
Isle of Anglesey	90	93.2	93	92	91.5	89.2	93.1	93.1	92	94.1	93.1
Gwynedd	90.3	92.6	92.7	91.4	92.9	91.2	93.7	95	94	95.2	94.4
Conwy	91.8	92.1	92.2	88.4	87.4	86.1	90.9	92.3	90.9	92.4	92.2
Denbighshire	87.7	92.5	89.4	84.7	86.9	86	86.5	90	90.9	92.1	90.8
Flintshire	90.8	91.8	92.5	91.5	90.7	90.4	91.9	92.5	92.5	91.5	92
Wrexham	90.5	92.7	93.9	93.5	91.5	93.4	94.6	92.9	94.8	93.8	94.2
Ceredigion	82	87.1	89.5	88.9	89.7	87.8	91.6	91.7	92.2	91	91.2
Pembrokeshire	80	84.9	86.7	88.3	87.8	87.3	87.8	90.6	90.5	90.5	86.8
Cardiff	78.4	85	89.8	88.6	88.3	89.3	91.3	90.5	92	90.8	89.8
Swansea	78.7	88.7	89.2	89.1	84.8	85.4	85.3	89.7	89.7	90.3	90.8
Neath Port Talbot	83.1	89.2	92.9	89.9	87.2	86.2	90.2	90.5	91.4	92.8	94
Bridgend	86.5	91.6	92.6	92.1	89.9	89.4	87.9	90.1	90.4	91.6	92
Vale of Glamorgan	84	88.6	89.6	89.2	89.3	86.3	89.7	89.3	90.4	90.7	91.5
Cardiff	81.6	84.8	86.4	86.9	85.6	84.2	83.8	87.4	87.3	87.9	88.7
Rhondda Cynon Taf	85	90.6	93	91.7	90	87.8	90.7	91.5	92.4	92.5	94.7
Caerphilly	78.6	91.1	92.1	93.1	93.3	92.1	93.2	94.3	94.8	95.1	94.5
Blaenau Gwent	81.9	89.3	93	91.9	91	89.7	93.5	94.2	95.6	94.9	93.5
Torfaen	84.1	89.6	92.9	93.3	91.2	92.5	92.9	94.1	94.6	93.6	95.3
Monmouthshire	69.8	83.2	81.7	84.7	80.6	77.7	86.7	88.5	91.1	89.1	88.8
Newport	78.2	86.7	88.2	87.5	85.3	87.7	89.5	88.3	91.7	90.2	89.6
Powys	75.3	84.7	87.8	86	82.8	83.2	87.2	87.8	88.5	87.5	90
Merthyr Tydfil	80.8	87.2	92.1	89.7	90.3	87.7	86.5	90	92.4	90.5	92.5

Fig. 2 Stats Wales® and Public Health Wales® Extract of MMR Coverage by Local Authority

- Ethnicity data from Infuse (free service providing data from 2001 and 2011 UK censuses [16]) – This provides the required breakdown by ethnicity from the 2011 census, retrieved by local authorities and allows data analysis of ethnicity to compare with deprivation levels, confirming if the MMR uptake is disproportionately affecting ethnic minority groups. Below is an extract of data retrieved for ethnicity group by local authorities.

CDU_ID	GEO_COD	GEO_LABE	GEO_TYPE	GEO_TY2	F1663	F1664	F1665	F1666	F1667	F1668	F1669	F1670	F1671	F1672	F1673	F1674	F1675	F1676	F1677	F1678	F1679
					Ethnic gro	Ethnic gro	Ethnic gro	Ethnic gro	Ethnic gro	Ethnic gro	Ethnic gro	Ethnic gro	Ethnic gro	Ethnic gro	Ethnic gro	Ethnic gro	Ethnic gro	Ethnic gro	Ethnic gro	Ethnic gro	Ethnic gro
434	W0600000	Isle of Ang Local Auth LA			69751	67349	476	65	630	180	41	180	79	135	33	53	153	117	50	25	6
435	W0600000	Gwynedd Local Auth LA			121874	115072	570	153	1778	287	126	332	219	461	220	176	905	408	195	70	24
436	W0600000	Conwy Local Auth LA			115228	109911	840	65	1733	294	124	275	201	317	101	134	376	324	114	54	31
437	W0600000	Denbighsh Local Auth LA			93734	89581	533	34	1106	251	80	269	151	240	157	111	346	576	104	35	22
438	W0600000	Flintshire Local Auth LA			152506	146185	693	95	3188	267	121	258	205	296	87	223	323	272	88	42	12
439	W0600000	Wrexham Local Auth LA			134844	125477	492	104	4574	264	180	326	240	857	181	206	426	651	526	57	42
440	W0600000	Ceredigion Local Auth LA			75922	70717	478	74	2174	198	75	251	212	367	81	91	322	238	164	86	16
441	W0600000	Pembroke Local Auth LA			122439	117092	834	454	1741	234	78	261	160	341	69	103	205	474	94	44	41
442	W0600000	Carmarthe Local Auth LA			183777	175591	754	335	3643	326	118	364	225	563	159	117	298	700	115	115	49
443	W0600000	Swansea Local Auth LA			239023	218655	1101	85	4856	548	280	781	551	1477	591	1944	2052	1739	1707	172	104
444	W0600000	Neath Por Local Auth LA			139812	135450	474	125	1038	384	75	262	189	280	125	311	280	373	97	175	27
445	W0600000	Bridgend Local Auth LA			139178	133056	474	63	1897	338	120	264	276	337	122	114	356	620	152	121	42
446	W0600000	The Vale o Local Auth LA			126336	119212	639	21	1966	629	247	431	388	566	216	121	454	610	165	252	72
447	W0600000	Cardiff Local Auth LA			346090	277798	2547	521	12248	3641	1742	2459	2189	7886	6354	4838	4168	4639	5213	1322	1666
448	W0600000	Rhondda C Local Auth LA			234430	225716	582	53	1890	550	192	420	344	656	267	106	1065	936	1140	99	69
449	W0600000	Caerphilly Local Auth LA			178806	173899	402	31	1513	454	147	296	277	327	123	32	495	369	121	112	9
450	W0600000	Blaenau G Local Auth LA			69814	67954	102	72	622	163	36	106	89	202	39	26	122	96	56	33	6
451	W0600000	Torfaen Local Auth LA			91075	88209	307	155	560	237	103	138	125	172	64	80	208	453	47	88	34
452	W0600000	Monmouth Local Auth LA			91323	87762	395	6	1363	174	51	232	167	245	54	40	193	368	80	45	19
453	W0600000	Newport Local Auth LA			145736	126756	769	84	3416	1318	360	669	405	1218	3127	1749	600	1292	1499	782	254
454	W0600000	Powys Local Auth LA			132976	127773	502	128	2424	208	82	294	176	145	9	67	171	750	42	70	20
455	W0600000	Merthyr Ty Local Auth LA			58802	55635	122	62	1572	154	46	151	111	168	50	45	120	313	118	10	15

Fig. 3 InFuse® Extract of Ethnicity Groups by Local Authority

- Deprivation data from Infuse – This provides the required breakdown by deprivation from the 2011 census, retrieved by local authorities for consistency. This will use the Townsend Index to analyse deprivation levels, comparing the deprivation levels with ethnicity groups to analyse MMR coverage in these areas. Below is an extract of data retrieved for material deprivation by local authorities.

CDU_ID	GEO_COD	GEO_LABE	GEO_TYPE	GEO_TY2	F248	F256	F260	F275	F556	F557	F989	F991	F2158	F2159	F2164	F2347	F2351	F2353
					Age : Age	Age : Age	Age : Age	Age : Age	Age : Age	Age : Age	Age : Age	Age : Age	Age : Age	Age : Age	Age : Age	Age : Age	Age : Age	Age : Age
434	W0600000	Isle of Ang Local Auth LA			2381	6949	17274	2266	247	1134	30594	5517	675	30594	73	30594	12444	8527
435	W0600000	Gwynedd Local Auth LA			3176	12300	27834	7814	373	2464	52473	11230	1358	52473	165	52473	21168	13156
436	W0600000	Conwy Local Auth LA			3362	12398	26697	3453	346	2077	51177	11128	1328	51177	121	51177	20409	15092
437	W0600000	Denbighsh Local Auth LA			2857	9696	23121	3239	265	1587	40546	8515	1185	40546	133	40546	14937	12855
438	W0600000	Flintshire Local Auth LA			4332	16875	45785	4240	372	1844	63781	10834	1809	63781	173	63781	22397	24054
439	W0600000	Wrexham Local Auth LA			4128	14567	39011	4409	316	1740	57029	12647	1948	57029	259	57029	17364	18908
440	W0600000	Ceredigion Local Auth LA			1469	6612	15161	7835	218	1587	31562	5803	845	31562	108	31562	13821	7502
441	W0600000	Pembroke Local Auth LA			3555	13507	27231	3311	449	2675	53122	9496	1283	53122	124	53122	22307	14251
442	W0600000	Carmarthe Local Auth LA			4962	18475	44839	5992	498	2952	78829	14826	1880	78829	207	78829	32648	23678
443	W0600000	Swansea Local Auth LA			6831	25141	59606	15342	558	2708	103497	26660	3262	103497	365	103497	34576	31683
444	W0600000	Neath Por Local Auth LA			4630	14335	36977	4397	268	1257	60393	15407	1551	60393	146	60393	21976	19503
445	W0600000	Bridgend Local Auth LA			4687	14633	38066	4228	272	1495	58515	12819	1401	58515	144	58515	20459	21889
446	W0600000	The Vale o Local Auth LA			3956	13657	34955	4235	375	2039	53505	10368	1136	53505	128	53505	18954	19693
447	W0600000	Cardiff Local Auth LA			11566	32468	97170	28383	750	3901	142557	41400	6323	142557	820	142557	37788	46474
448	W0600000	Rhondda C Local Auth LA			8104	23068	61225	9914	402	2423	99663	26978	2565	99663	291	99663	36338	34422
449	W0600000	Caerphilly Local Auth LA			6731	17292	50160	5869	342	1842	74479	18137	2249	74479	216	74479	24188	27444
450	W0600000	Blaenau G Local Auth LA			3557	6763	18147	2245	132	586	30416	8811	1017	30416	91	30416	10019	8865
451	W0600000	Torfaen Local Auth LA			3163	9535	25574	2662	177	854	38524	9090	1201	38524	121	38524	12176	13242
452	W0600000	Monmouth Local Auth LA			2217	9352	24246	2838	293	1648	38233	5807	771	38233	97	38233	15269	12873
453	W0600000	Newport Local Auth LA			5616	15531	39177	5591	318	1593	61172	17076	2157	61172	243	61172	18229	21043
454	W0600000	Powys Local Auth LA			2928	13955	31210	3539	482	3109	58345	8757	1181	58345	125	58345	25626	14464
455	W0600000	Merthyr Ty Local Auth LA			2481	5913	15882	2078	111	592	24264	7213	1046	24264	116	24264	8277	7566

Fig. 4 InFuse® Extract of Material Deprivation by Local Authority

The above data will assist with finding any patterns and trends between MMR coverage, deprivation, and ethnicity groups to determine if the hypothesis has been proved or not.

Data Analysis and Results

MMR Uptake in Wales

For an underlying generalisation of MMR coverage in Wales, and with all areas geocoded for improved reliability, the data periods used (2012/13, 2017/18, and 2022/23) represent the beginning, middle, and end of the 11-year period to best describe the MMR coverage over a period. All MMR coverage data is visualised to show Wales in green, cream, and red, indicating the local authority areas having the highest and lowest MMR coverage, highlighting any areas appearing to have continually lower uptakes. This provides the best visual representation to show any patterns and trends quickly and effectively [17].

For the 1st dose coverage in 2012/13, while 5 local authorities had a 1st dosage coverage of at least 95% (with Flintshire the highest at 97%), 9 local authorities had a 1st dose coverage of less than 90% (with Monmouthshire the lowest at 81.8%), providing a Welsh average of 91.3%.

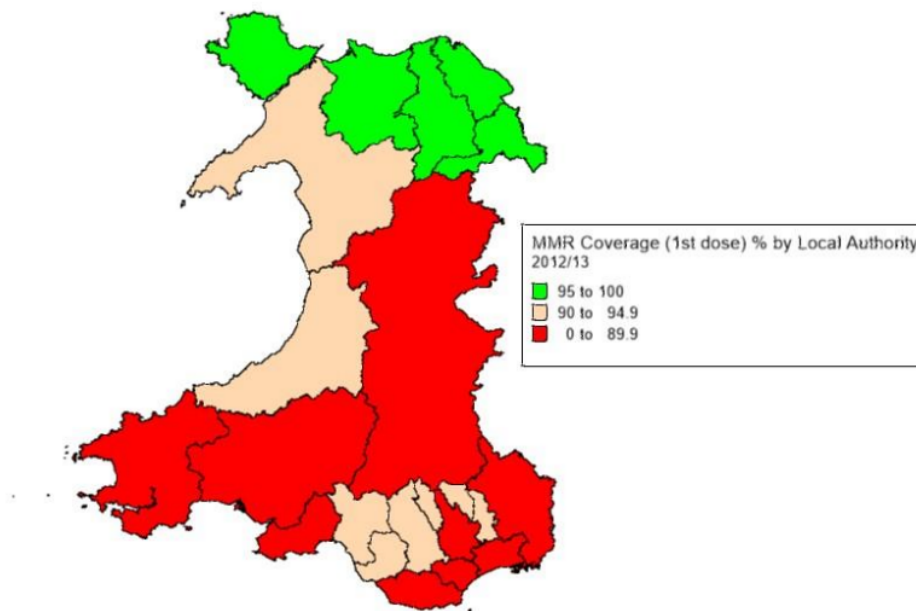


Fig. 5 1st Dose MMR Coverage in Wales – 2012/13

However, the 2nd MMR dosage coverage in 2012/13 was worse, with 17 local authorities recording less than 90%, with Powys the lowest at 75.3%, providing a Welsh average of 81.7%.

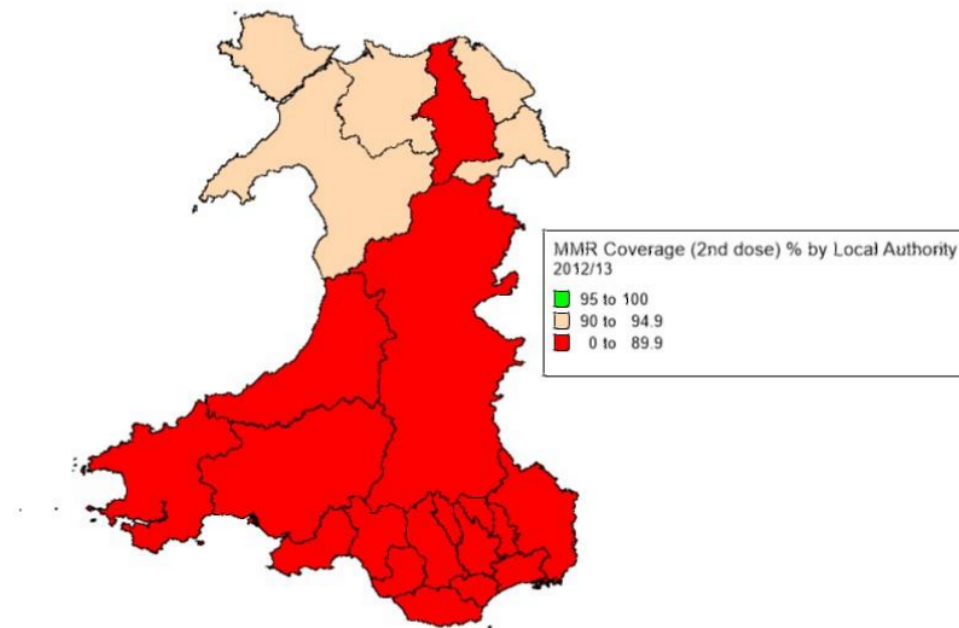


Fig. 6 2nd Dose MMR Coverage in Wales – 2012/13

Comparing the 1st and 2nd MMR coverage for 2012/13, the highest MMR coverage within Wales are areas in North Wales, potentially indicating why there have been no outbreaks of measles in North Wales compared to areas of South Wales. However, there appears to be reluctance for the 2nd dose, meaning that with the 1st dose not providing protection, it could partially explain the measles outbreak in 2012.

MMR Coverage (1st dose) % by Local Authority 2017/18

Color	MMR Coverage (1st dose) %
Green	95 to 100
Orange	90 to 94.9
Red	0 to 89.9

Fig. 7 1st Dose MMR Coverage in Wales – 2017/18

However, like in 2012/13, the 2nd MMR dosage coverage in 2017/18 was worse, with 17 local authorities recording less than 90% (Monmouthshire the lowest at 77.7%), providing a Welsh average of 86.9%, which while higher than in 2012/13, is still worse than the 1st dose coverage.

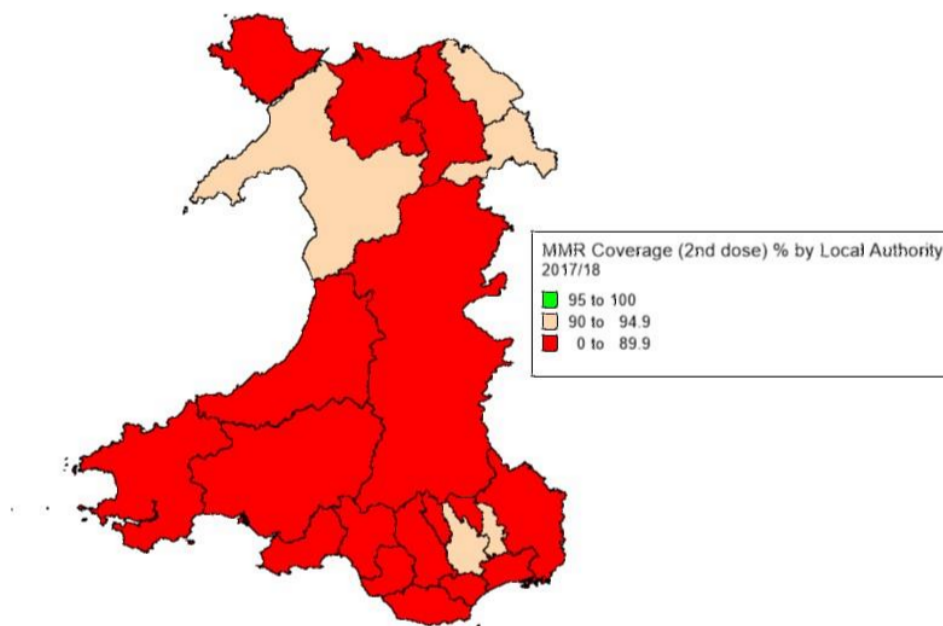


Fig. 8 2nd Dose MMR Coverage in Wales – 2017/18

Comparing both periods, North Wales continues to have high MMR coverage compared to the rest of Wales, though Monmouthshire continues to have low MMR coverage. This could be due to the low population and density within Monmouthshire, though other local authorities like Anglesey and Denbighshire with similar populations and densities have continuously higher uptakes. Overall, there is an increase in the MMR uptake, suggesting that the measles outbreak in 2012 may have prompted parents to have their children vaccinated. However, while the 2nd dose coverage increased, there is still reluctance towards the 2nd MMR dose.

For the 1st dose coverage in 2022/23, there is high coverage in Wales, with 11 local authorities recording at least 95% (with Neath Port Talbot and Caerphilly at 97.3% and 97.1% respectively), providing a Welsh average of 94.8%, a notable increase compared to previous periods.

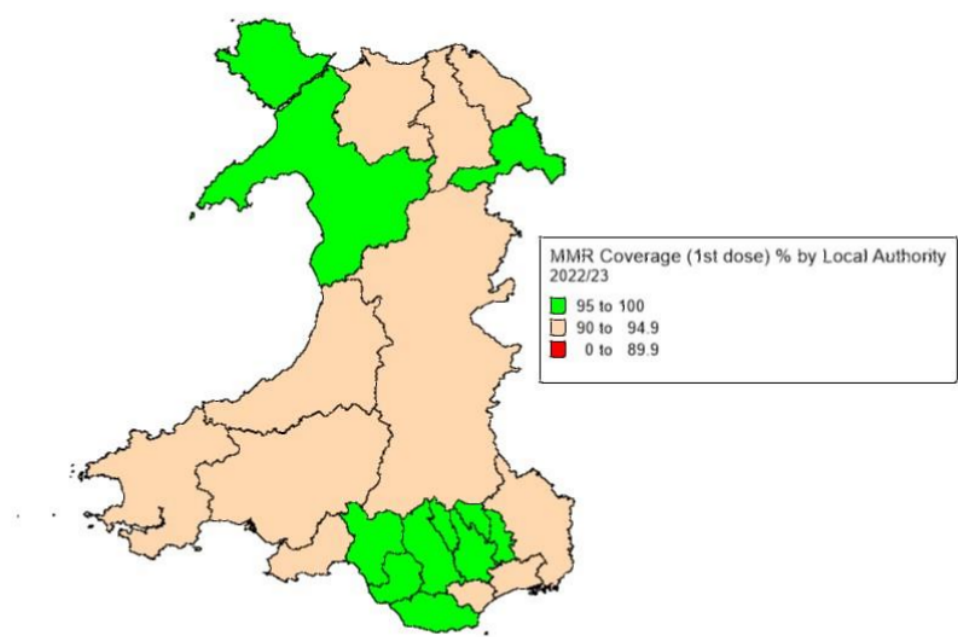


Fig. 9 1st Dose MMR Coverage in Wales – 2022/23

However, like previous periods, the 2nd MMR dosage coverage in 2022/23 was worse, though did improve comparatively. 5 local authorities were recording less than 90% (with Pembrokeshire the lowest at 86.8%), though Torfaen recorded a high 2nd dose coverage of 95.3%. This provided a Welsh average of 91.3% and while still worse than the 1st dose coverage, the gap between the 1st and 2nd dose coverage is closer than previous periods.

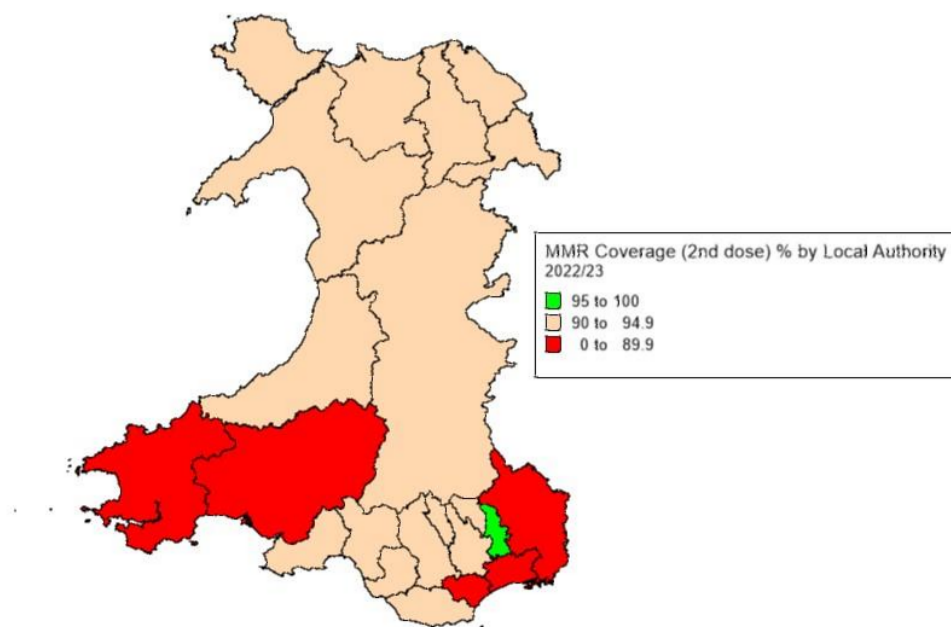


Fig. 10 2nd Dose MMR Coverage in Wales – 2022/23

Compared to previous periods, North Wales and parts of the South Wales valleys continued to have the highest coverage of the MMR vaccination, with Cardiff having some of the lowest vaccination coverage. However, compared to previous periods, there is a decrease in the 1st dose MMR uptake, suggesting a reluctance again to have the MMR vaccination, though increases in the 2nd dose and overall MMR coverage suggest that children are being fully vaccinated.

Ethnicity

This builds on the MMR uptake data previously used to highlight the following ethnicity groups.

- Mixed (black and white) ethnicity
- Asian (including Indian and Chinese) ethnicity.
- Black (including African and Caribbean) ethnicity.
- Other (including Arab) ethnicity.

All ethnicity data is visualised by local authority and by the proportion size in each area, whereby the bigger they are, the bigger the ethnicity representation within that area.

Mixed Ethnicities

For the 1st dose coverage in 2012/13, while Cardiff, Newport, and the Vale of Glamorgan (the highest proportion of mixed ethnicity groups at 2.90%, 1.89%, and 1.34% respectively) had lower 1st dose coverages at 89.9%, 87.7% and 89.8% respectively, Monmouthshire (81.8%) and Powys (86.4%) with smaller proportions had lower coverage, while North Wales with higher proportions had higher coverage.

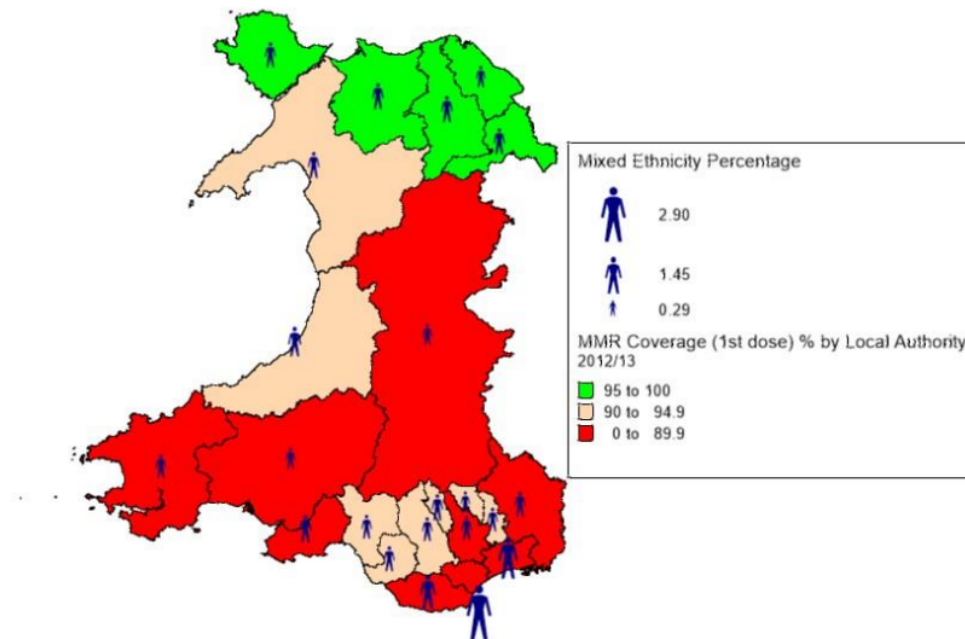


Fig. 11 1st Dose MMR Coverage by Mixed Ethnicity in Wales – 2012/13

For the 2nd MMR dose coverage in 2012/13, there is little evidence to suggest a link with the disproportion of mixed ethnicities, as while Newport had one of the lowest coverage rates (78.2%), Monmouthshire, Carmarthenshire, and Powys with smaller proportions had low uptakes (69.8%, 78.4% and 75.3% respectively).

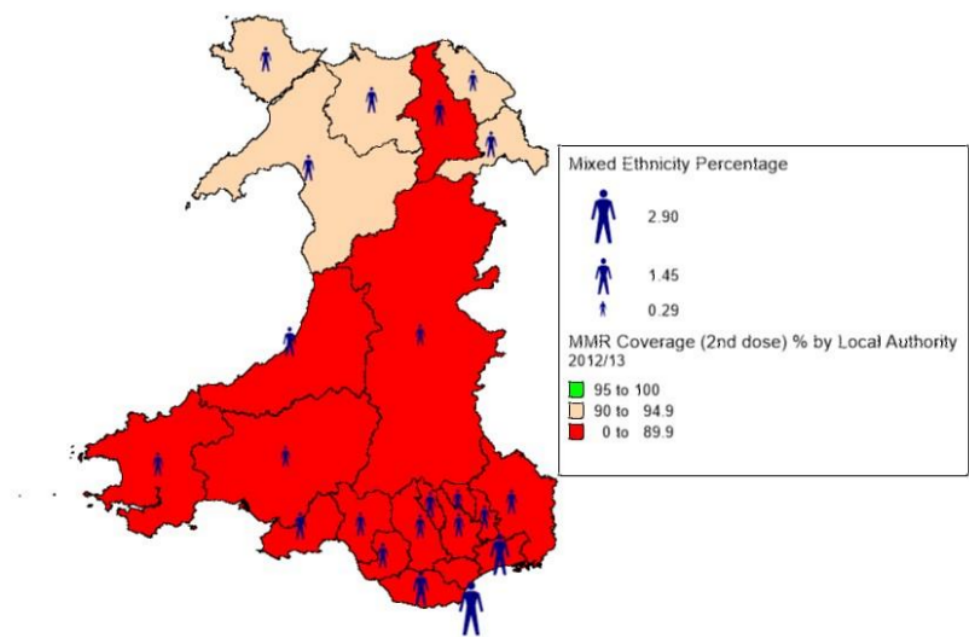


Fig. 12 2nd Dose MMR Coverage by Mixed Ethnicity in Wales – 2012/13

For the 1st dose coverage in 2017/18, while Cardiff had low coverage (90.7%), Newport and Vale of Glamorgan with similar proportions had coverage of 93.3% and 92.2% respectively, while Monmouthshire and Denbighshire with smaller proportions had lower coverage (84.6% and 89.6% respectively).

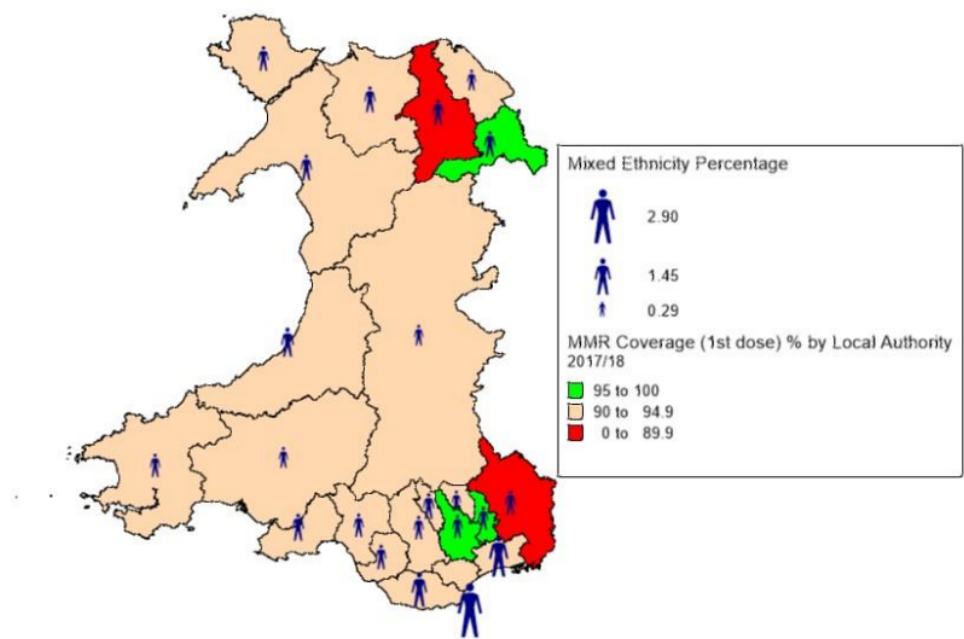


Fig. 13 1st Dose MMR Coverage by Mixed Ethnicity in Wales – 2017/18

For the 2nd MMR dosage coverage in 2017/18, most of Wales recorded less than 90% coverage (Monmouthshire the lowest at 77.7%). However, while Cardiff recorded low coverage (84.2%), areas like Powys and Denbighshire continue to have lower coverage with smaller proportions (83.2% and 86% respectively).

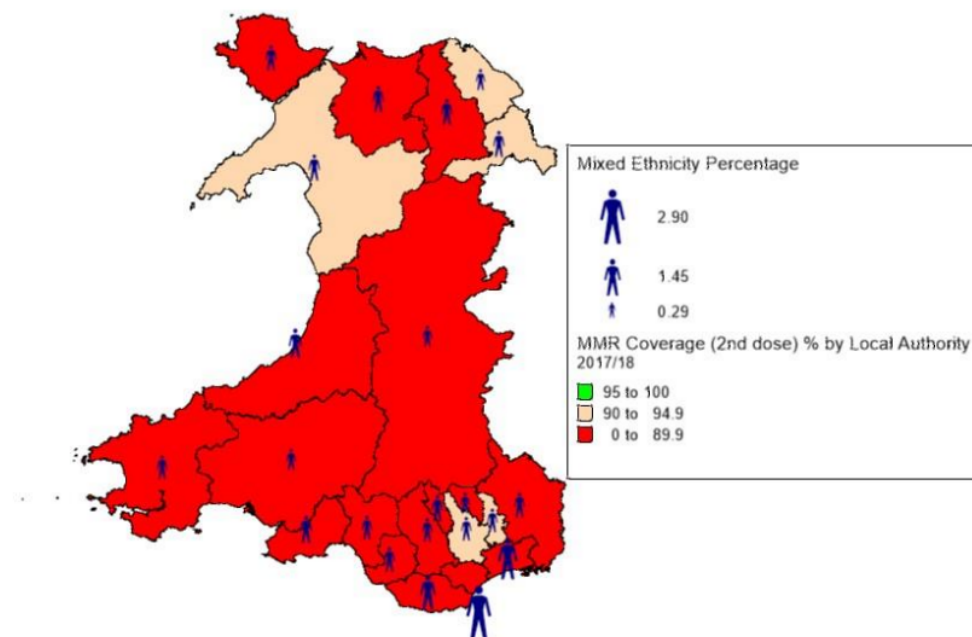


Fig. 14 2nd Dose MMR Coverage by Mixed Ethnicity in Wales – 2017/18

For the 1st dose coverage in 2022/23, there was high coverage throughout Wales, and while Cardiff had low coverage (93.4%), areas like Carmarthenshire and Pembrokeshire also recorded lower coverages (93.5% and 92.6% respectively), despite having lower proportions.

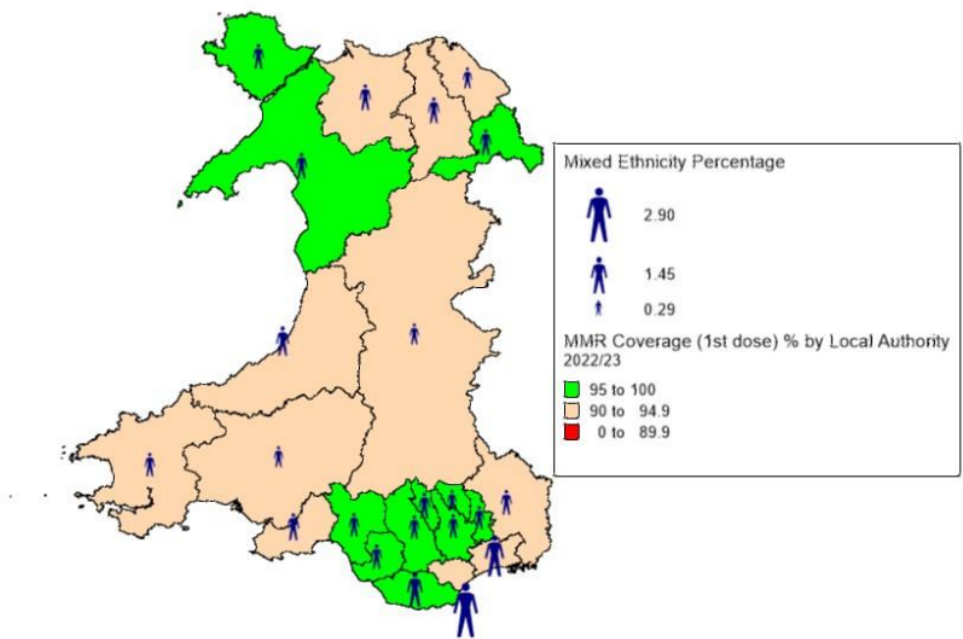


Fig. 15 1st Dose MMR Coverage by Mixed Ethnicity in Wales – 2022/23

For the 2nd MMR dosage coverage in 2022/23, Cardiff again had low coverage (88.7%), though areas like Monmouthshire and Pembrokeshire also recorded low coverage (88.8% and 86.8% respectively), while Wrexham, having a slightly smaller proportion compared to Newport and the Vale of Glamorgan, had a high coverage (94.2%).

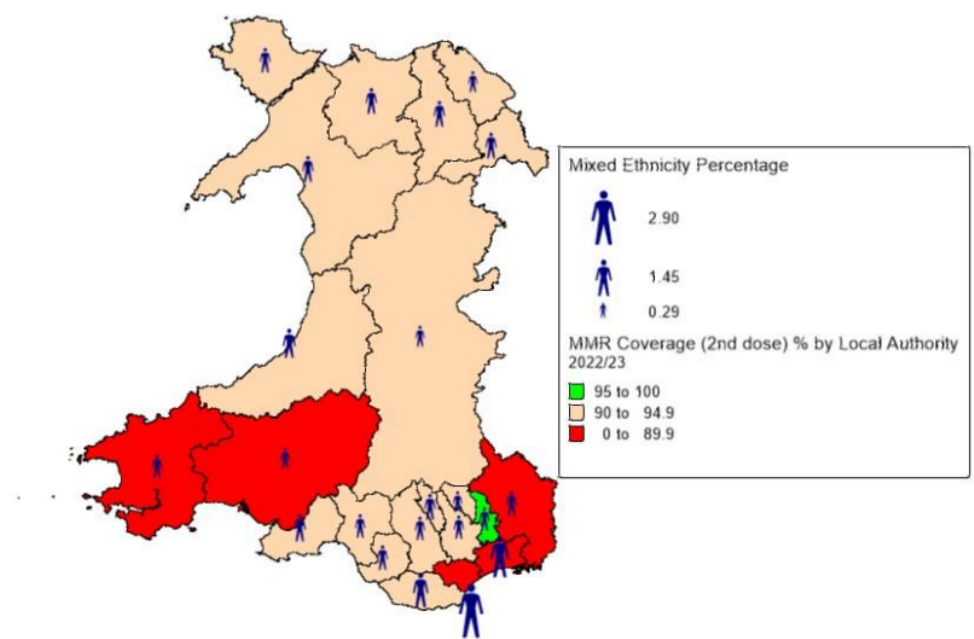


Fig. 16 2nd Dose MMR Coverage by Mixed Ethnicity in Wales – 2022/23

Asian Ethnicities

For the 1st dose coverage in 2012/13, the areas with the highest Asian ethnicity proportions (Cardiff, Newport, and Swansea with 8.06%, 5.48%, and 3.26% respectively) showed low coverage (89.9%, 87.7%, and 89.1% respectively), though areas like Carmarthenshire (89.4%) and Monmouthshire (81.8%) had similar or lower coverage, with Anglesey showing a high coverage (96%), despite having a smaller proportion.

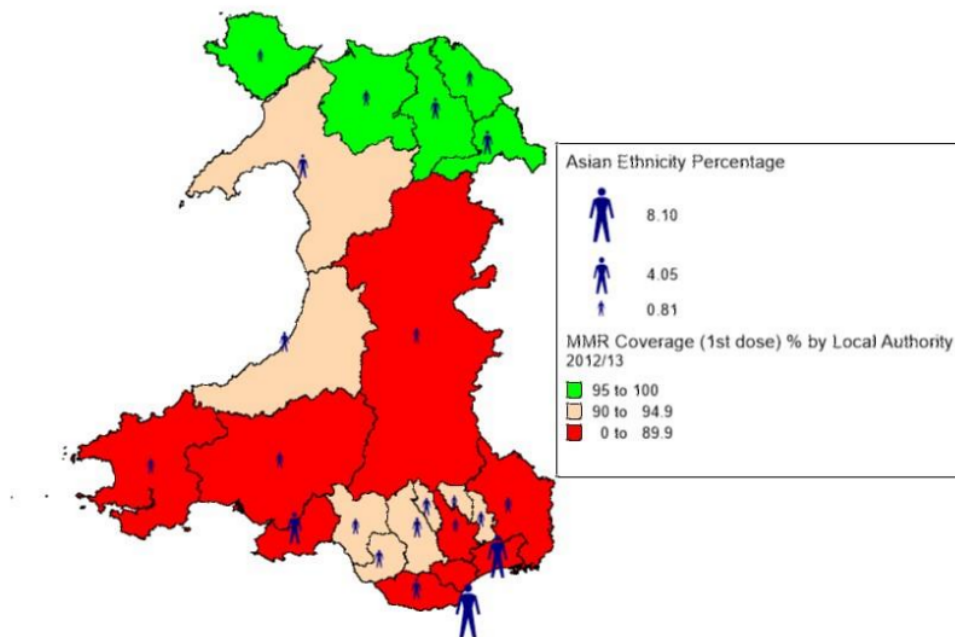


Fig. 17 1st Dose MMR Coverage by Asian Ethnicity in Wales – 2012/13

For the 2nd MMR dosage coverage in 2012/13, there is little evidence of links with the disproportion of Asian ethnicities, as while Newport and Swansea had low coverages (78.2% and 78.7% respectively), areas like Pembrokeshire, Caerphilly and Powys with smaller proportions also had low uptakes (80%, 78.6% and 75.3% respectively).

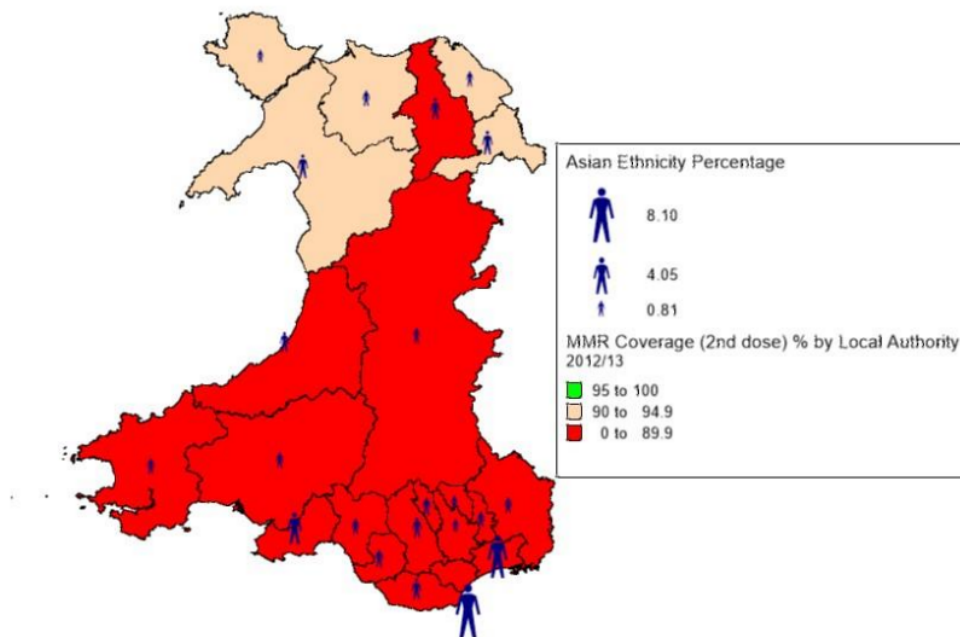


Fig. 18 2nd Dose MMR Coverage by Asian Ethnicity in Wales – 2012/13

For the 1st dose coverage in 2017/18, while Cardiff and Swansea had low coverages (90.7% and 91.8% respectively), Monmouthshire (84.6%) and Denbighshire (89.6%) with smaller proportions had lower uptakes, with areas like Wrexham with a higher proportion had high coverage (95.5%).

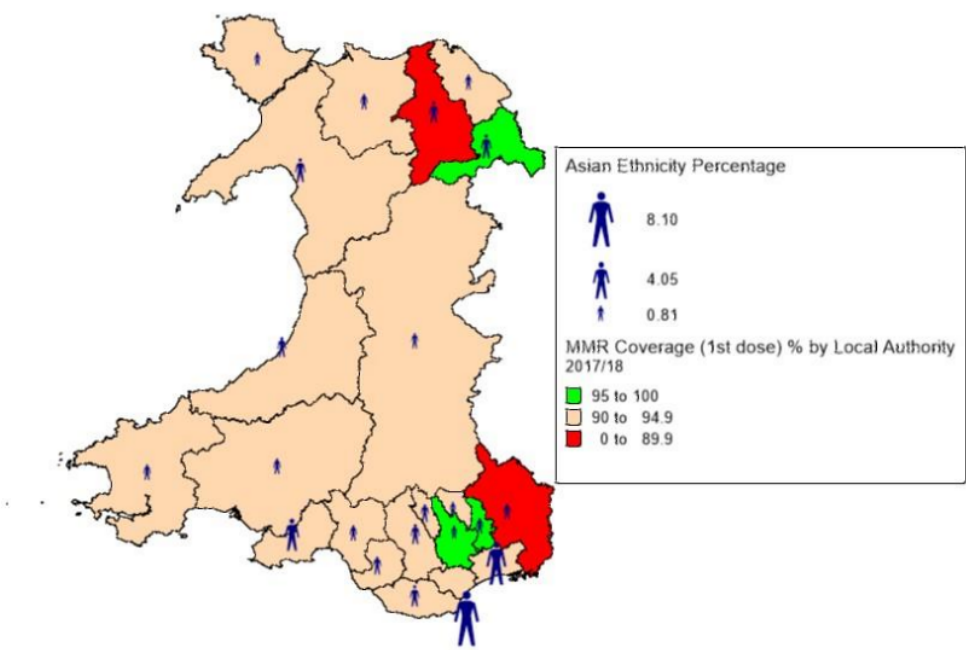


Fig. 19 1st Dose MMR Coverage by Asian Ethnicity in Wales – 2017/18

For the 2nd MMR dosage coverage in 2017/18, while Cardiff and Swansea recorded low coverages (84.2% and 85.4% respectively), areas like Conwy and Powys also had low coverages (86.1% and 83.2% respectively), despite smaller proportions.

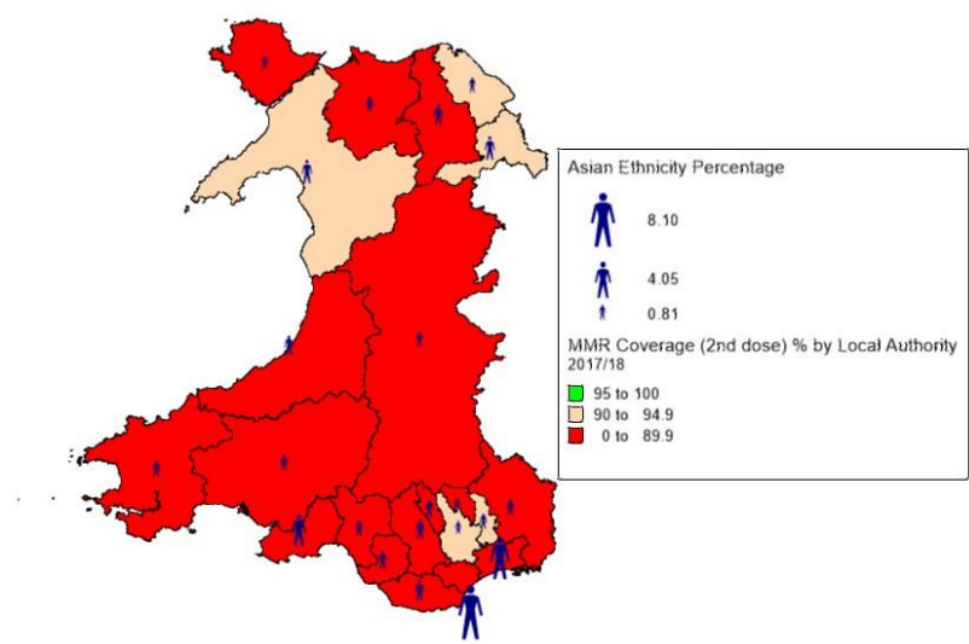


Fig. 20 2nd Dose MMR Coverage by Asian Ethnicity in Wales – 2017/18

For the 1st dose coverage in 2022/23, while Cardiff, Newport, and Swansea had lower coverages (93.4%, 93.6%, and 94% respectively), areas like Monmouthshire and Powys also recorded low coverages (91.7% and 93.6% respectively), despite having smaller proportions.

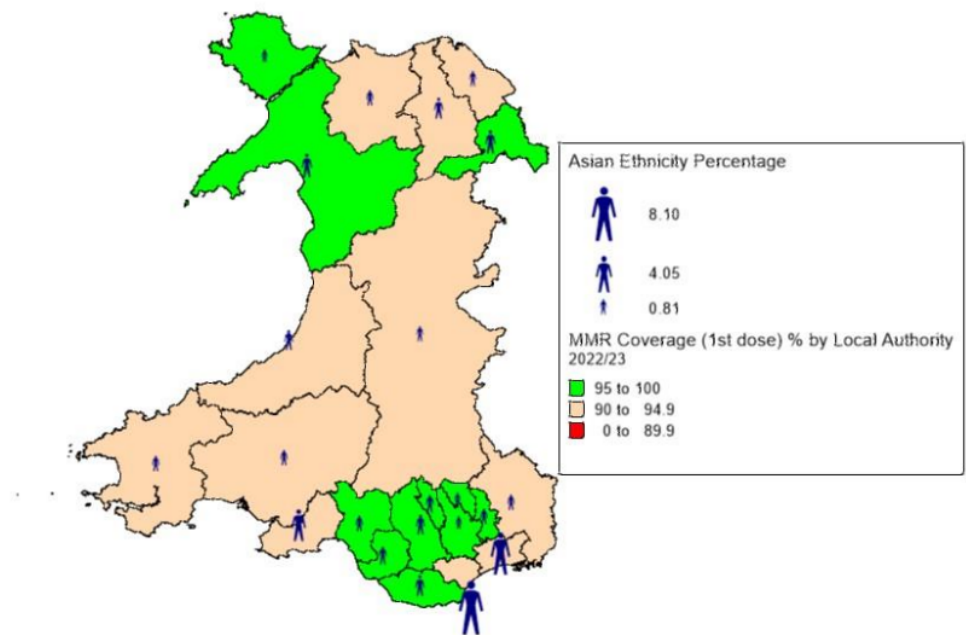


Fig. 21 1st Dose MMR Coverage by Asian Ethnicity in Wales – 2022/23

For the 2nd MMR dosage coverage in 2022/23, Cardiff and Newport had low coverages (88.7% and 89.6% respectively), though areas like Carmarthenshire and Pembrokeshire also recorded low coverages (89.8% and 86.8% respectively), while Torfaen with a smaller proportion had the highest coverage (95.3%).

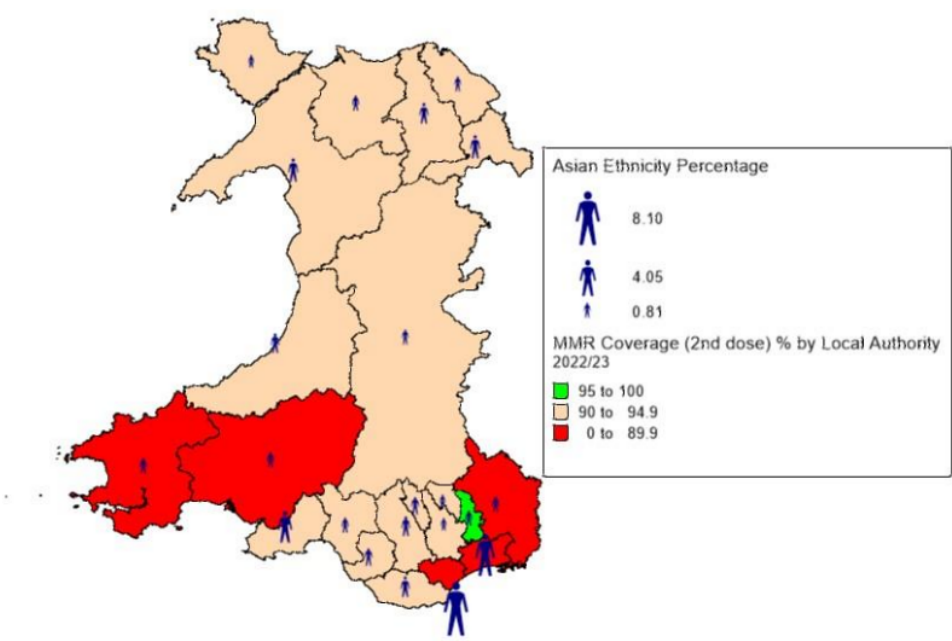


Fig. 22 2nd Dose MMR Coverage by Asian Ethnicity in Wales – 2022/23

Black Ethnicities

For the 1st dose coverage in 2012/13, the areas with the highest proportion of black ethnicity (Cardiff, Newport, and Swansea with 2.37%, 1.74%, and 0.83% respectively) showed low coverages (89.9%, 87.7%, and 89.1% respectively), though smaller representations in areas like Pembrokeshire (89.9%), Powys (86.4%) and Caerphilly (89.7%) had similar or lower coverage, with North Wales areas like Conwy (96.3%) and Flintshire (97%) showing high coverage rates, despite vastly lower proportions (0.17% and 0.09% respectively).

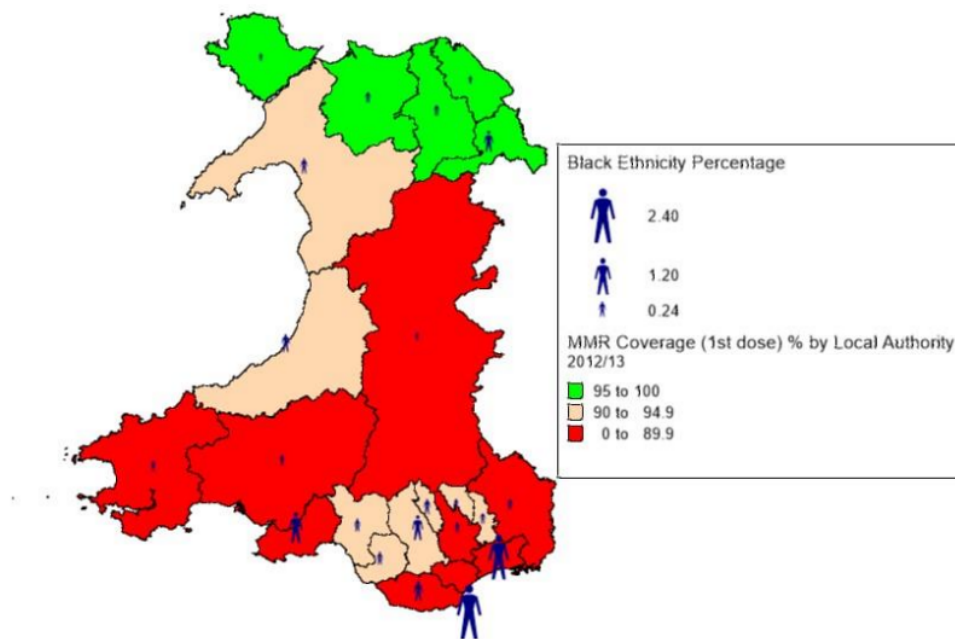


Fig. 23 1st Dose MMR Coverage by Black Ethnicity in Wales – 2012/13

For the 2nd MMR dosage coverage in 2012/13, there was minimal evidence confirming links with disproportion of black ethnicities, as while more densely populated areas like Cardiff (81.6%) had low coverage, most of Wales had low coverage, with smaller proportion areas like Carmarthenshire and Monmouthshire having low coverages (78.4% and 69.8% respectively).

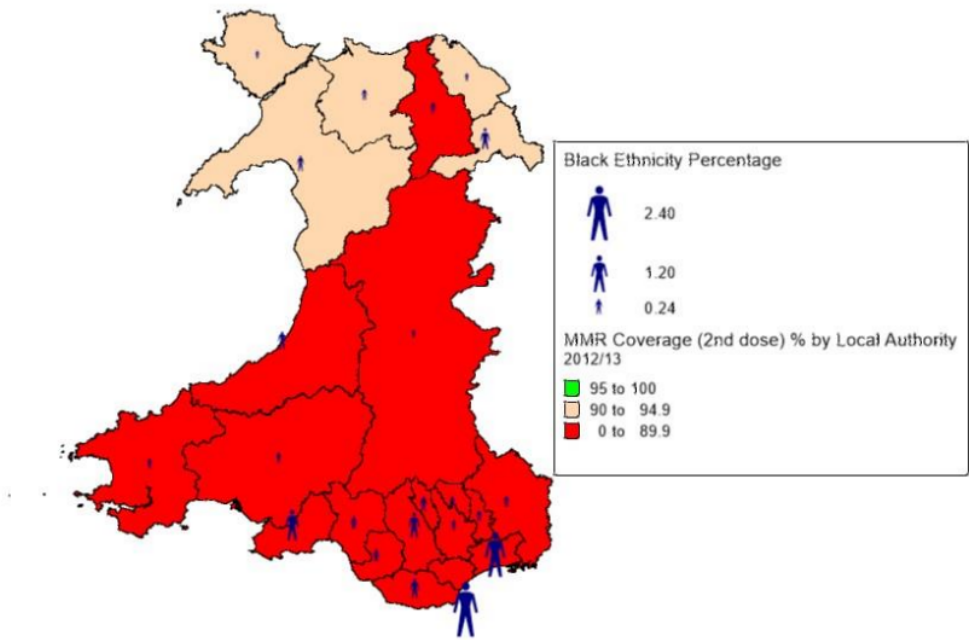


Fig. 24 2nd Dose MMR Coverage by Black Ethnicity in Wales – 2012/13

For the 1st dose coverage in 2017/18, while Cardiff and Swansea had lower coverages, areas like Powys with smaller proportions also had low coverage (90.1%), while areas like Rhondda-Cynon-Taf with a higher proportion had higher coverage (94.4%).

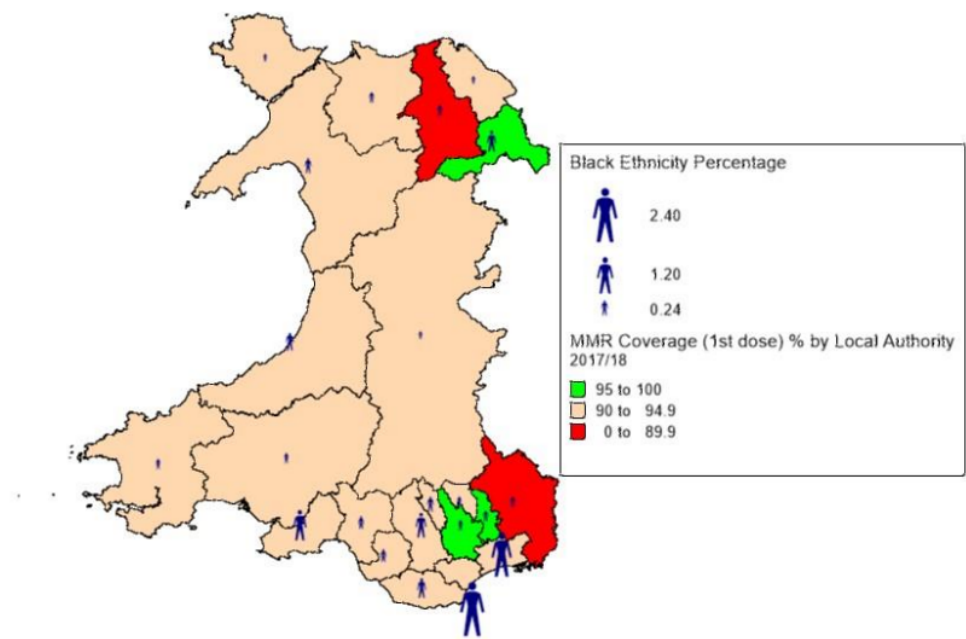


Fig. 25 1st Dose MMR Coverage by Black Ethnicity in Wales – 2017/18

For the 2nd MMR dosage coverage in 2017/18, while bigger areas like Cardiff, Swansea, and Vale of Glamorgan had lower coverage, areas like Merthyr Tydfil and Pembrokeshire also had lower coverage with a smaller proportion (87.7% and 87.3% respectively).

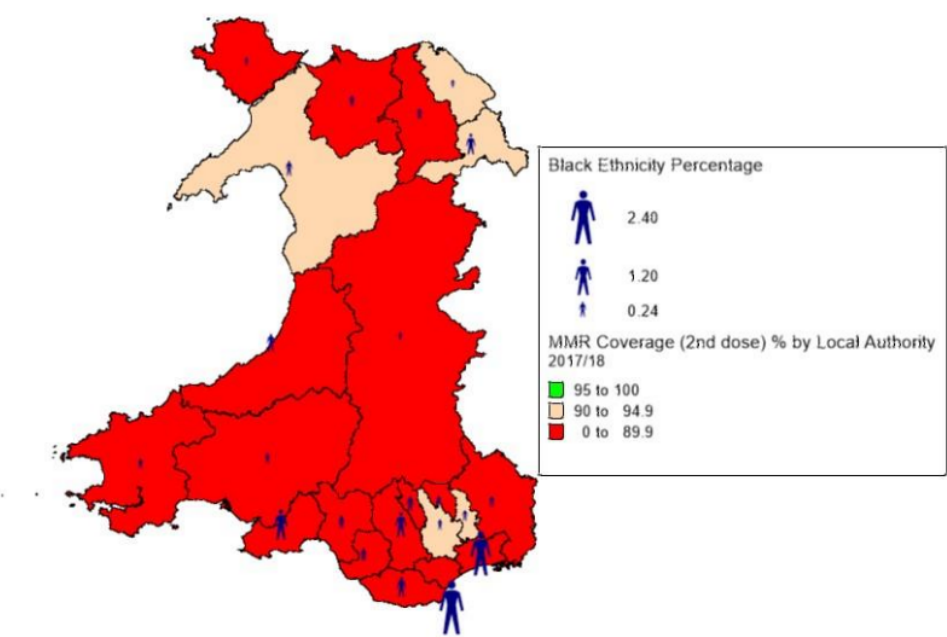


Fig. 26 2nd Dose MMR Coverage by Black Ethnicity in Wales – 2017/18

For the 1st dose coverage in 2022/23, while some built-up areas had some of the lowest coverages, areas like Pembrokeshire (92.6%) also recorded low coverage, despite having a lower proportion.

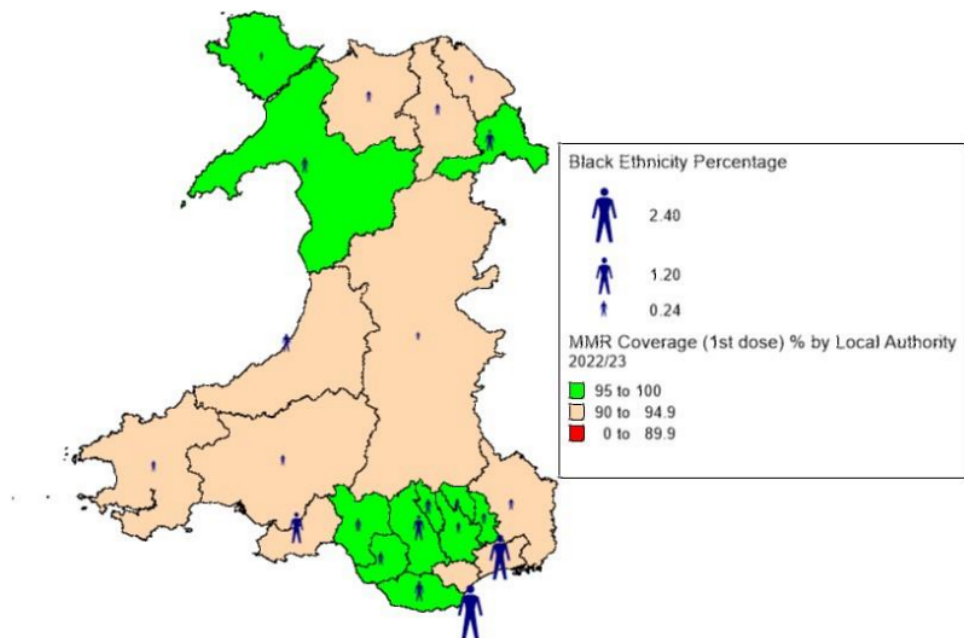


Fig. 27 1st Dose MMR Coverage by Black Ethnicity in Wales – 2022/23

For the 2nd MMR dosage coverage in 2022/23, some built-up areas like Swansea (90.8%) had low coverage, though areas like Monmouthshire and Powys also recorded low coverages (88.8% and 90% respectively), despite lower proportions, while more built-up area like Rhondda-Cynon-Taf had high coverage (94.7%).

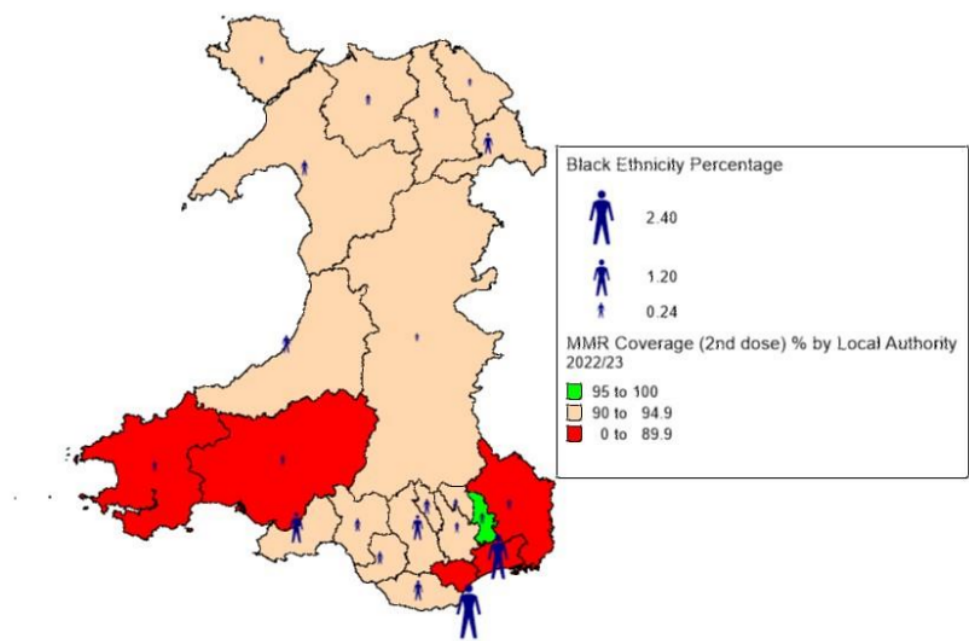


Fig. 28 2nd Dose MMR Coverage by Black Ethnicity in Wales – 2022/23

Other Ethnicities

For the 1st dose coverage in 2012/13, the areas with the highest proportion of other ethnicities (Cardiff, Swansea, and Newport with 1.98%, 1.00%, and 0.99% respectively) showed low coverages, though smaller representations in areas like Monmouthshire (81.8%) had similar or lower coverage, while areas like Denbighshire (96%) showed high coverage rates, despite a lower proportion (0.15%).

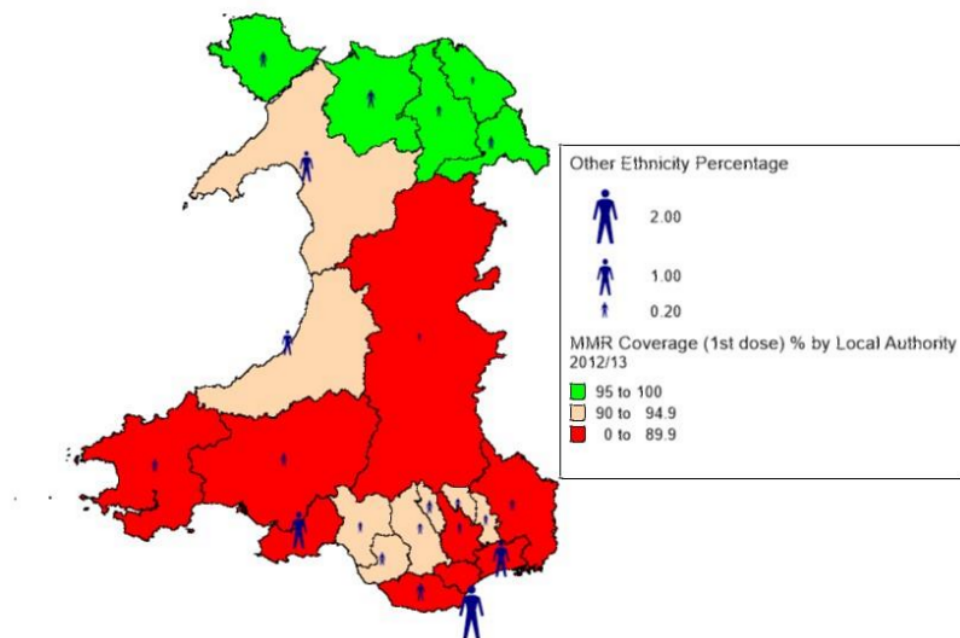


Fig. 29 1st Dose MMR Coverage by Other Ethnicity in Wales – 2012/13

For the 2nd MMR dosage coverage in 2012/13, there was minimal evidence showing links with other ethnicity disproportions, as while Cardiff had low coverage (81.6%), areas like Powys (75.3%) with a smaller proportion also had low coverage.

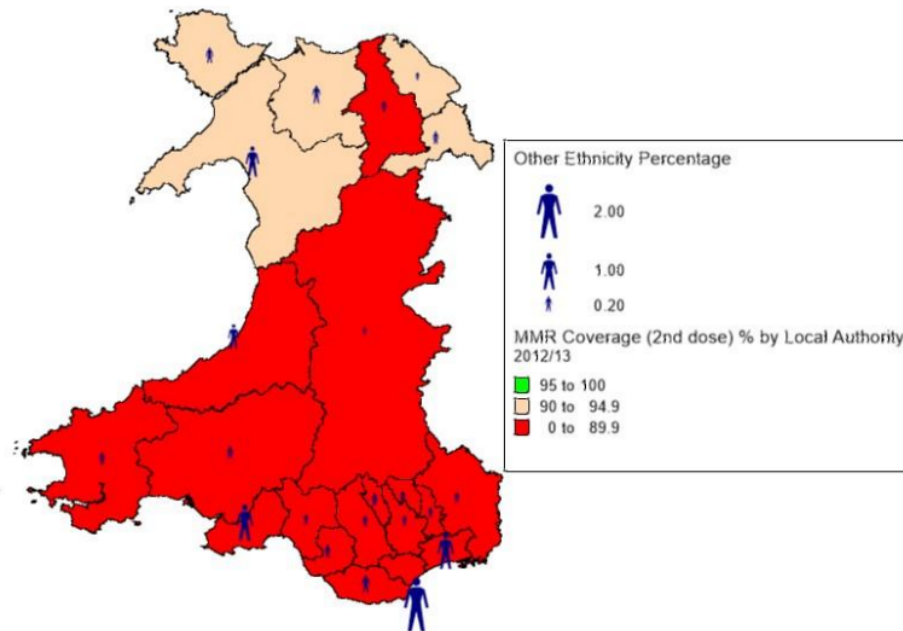


Fig. 30 2nd Dose MMR Coverage by Other Ethnicity in Wales – 2012/13

For the 1st dose coverage in 2017/18, while some built-up areas like Neath Port Talbot and Vale of Glamorgan had lower coverages (92.4% and 92.2% respectively), areas like Powys (90.1%) and Pembrokeshire (92.5%) with smaller proportions had similar or lower coverages, while areas like Gwynedd with a higher proportion had higher coverage (94.3%).

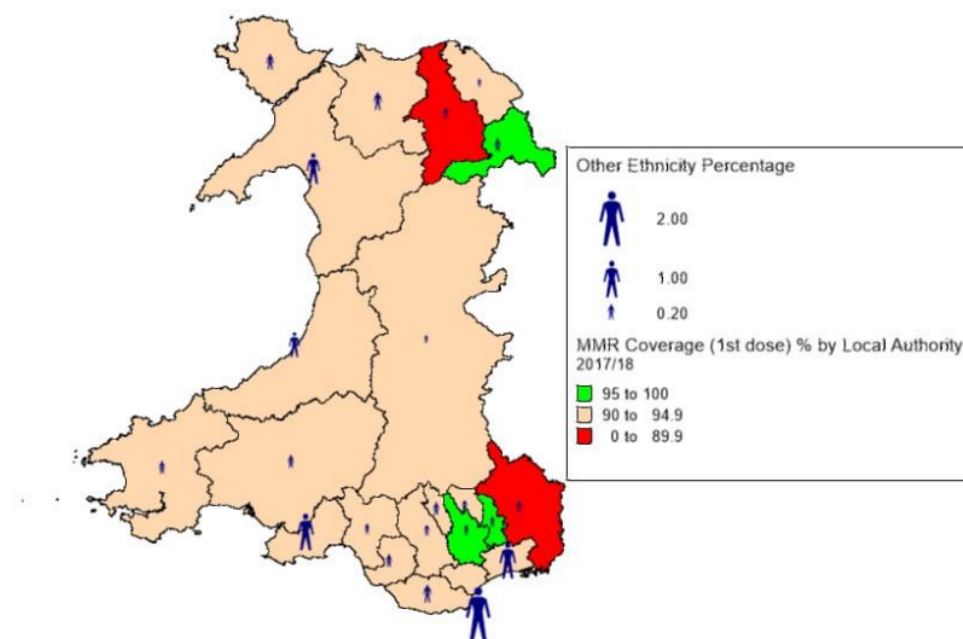


Fig. 31 1st Dose MMR Coverage by Other Ethnicity in Wales – 2017/18

For the 2nd MMR dosage coverage in 2017/18, like other ethnic minorities, some built-up areas recorded low coverages, though other built-up areas like Wrexham (93.4%) and Caerphilly (92.1%) had high coverages. More rural areas like Pembrokeshire (87.3%), despite having a smaller proportion, had low coverages.

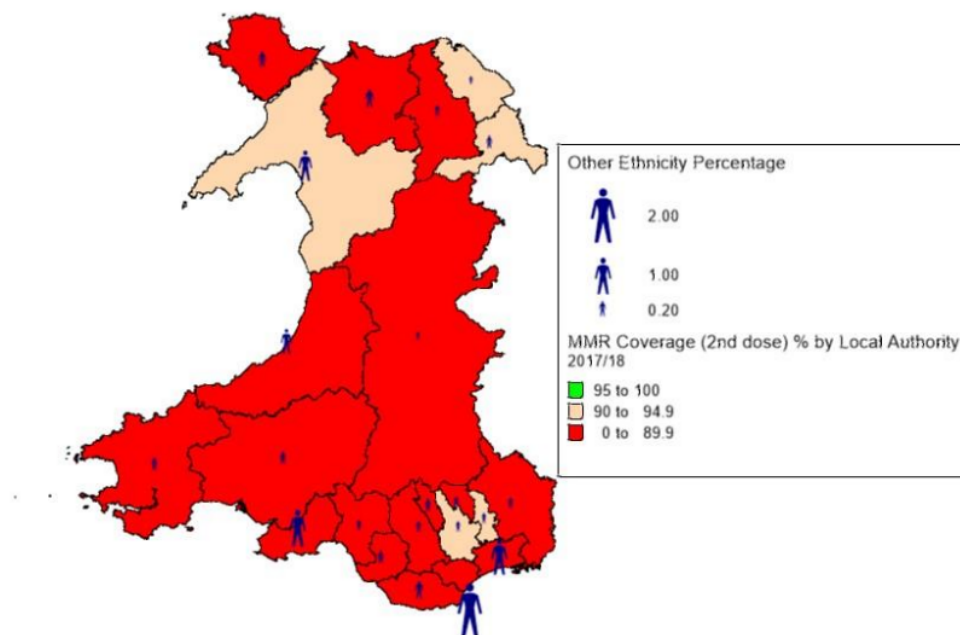


Fig. 32 2nd Dose MMR Coverage by Other Ethnicity in Wales – 2017/18

For the 1st dose coverage in 2022/23, while some built-up areas had low coverages, areas like Pembrokeshire (92.6%) and Carmarthenshire (93.5%) also recorded low coverage rates, despite having lower proportions.

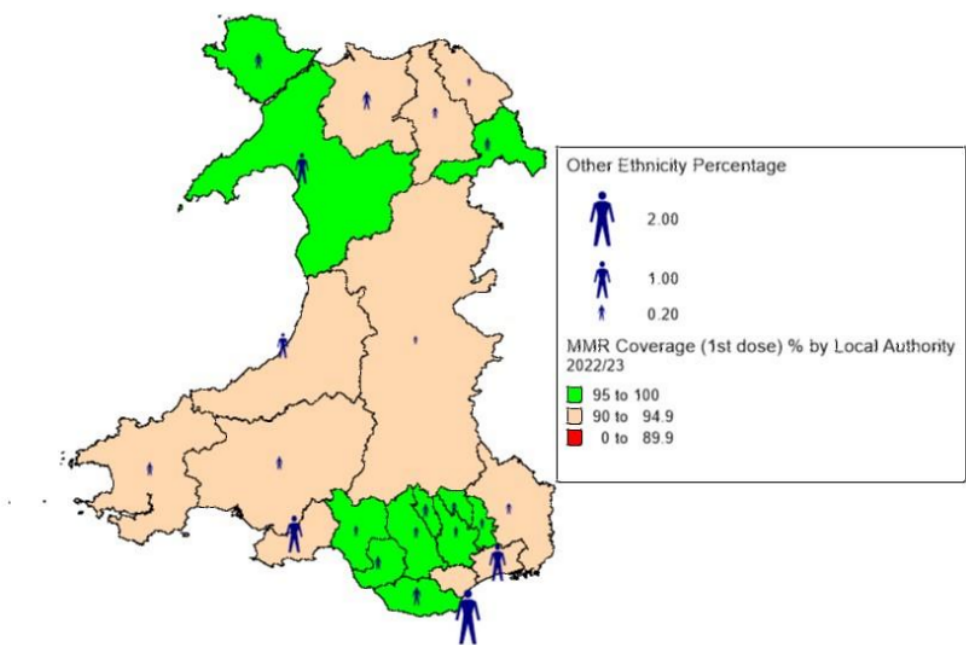


Fig. 33 1st Dose MMR Coverage by Other Ethnicity in Wales – 2022/23

For the 2nd MMR dosage coverage in 2022/23, built-up areas like Swansea (90.8%) had low coverage, though areas like Powys (90%) also recorded low coverages, while smaller proportion areas like Neath Port Talbot had a high coverage at 94%.

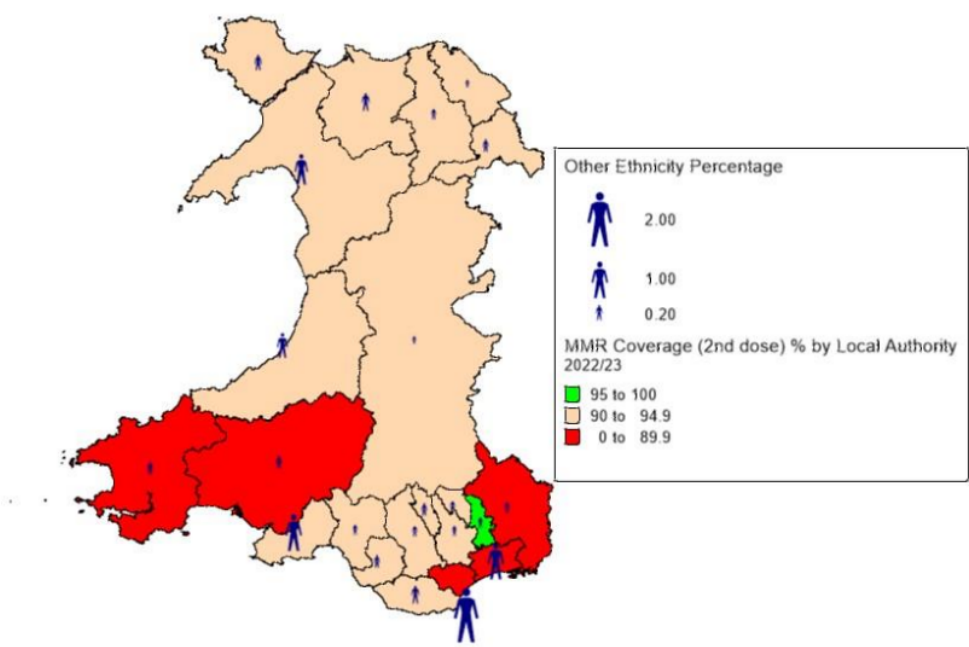


Fig. 34 2nd Dose MMR Coverage by Other Ethnicity in Wales – 2022/23

Deprivation

The deprivation levels were calculated via the Townsend Index, whereby areas with higher positive scores show more deprivation, and areas with higher negative scores show lower deprivation [18].

This uses previous ethnicity data to analyse whether there are links between higher proportions of ethnic minority groups and deprivation within local authorities, analysing the MMR 1st and 2nd dose coverage to deprivation and ethnicity groups to investigate any patterns and trends. The deprivation levels are visualised by colour shadings, whereby lighter areas indicate lower deprivation and darker areas indicate higher deprivation.

Mixed Ethnicities

The highest deprivation levels occur within Cardiff, Newport, Merthyr Tydfil, and Blaenau Gwent, of which the highest proportions are in Cardiff and Newport, indicating that mixed ethnicity groups experience higher deprivation. However, compared to other areas, Merthyr Tydfil has a comparable proportion (0.79%) to less deprived areas like Gwynedd (0.79%) and Conwy (0.78%), while Blaenau Gwent (0.56%) has a low proportion and is comparable to affluent areas like Powys (0.57%) and Pembrokeshire (0.60%). The Vale of Glamorgan also has low deprivation, despite having the third highest proportion (1.34%).

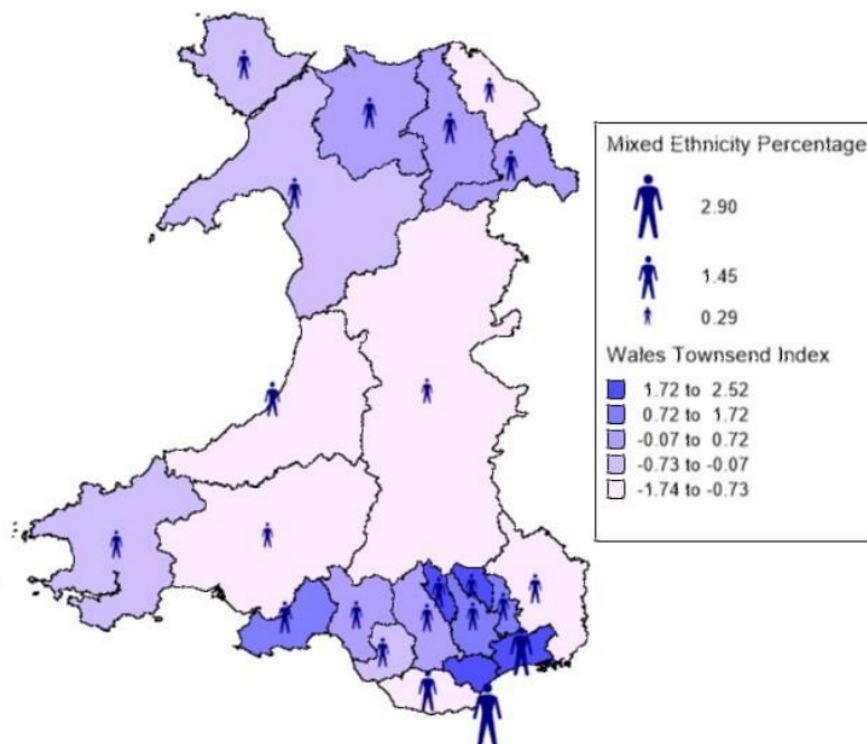


Fig. 35 Deprivation by Mixed Ethnicity

When comparing MMR coverages over the three periods, Cardiff consistently had low coverage, indicating that with high deprivation levels and the highest proportion, there is a link with the low

MMR coverage. However, while Newport also recorded low coverage rates, affluent areas like Monmouthshire and Powys consistently recorded low MMR coverages and had low proportions.

Asian Ethnicities

The highest ethnic proportions are in Cardiff, Newport, and Swansea, indicating that they experience high deprivation. However, Blaenau Gwent has comparable proportions (0.69%) to less deprived areas like Anglesey (0.70%) and Pembrokeshire (0.97%). Ceredigion, despite having a high proportion (1.45%), has low deprivation.

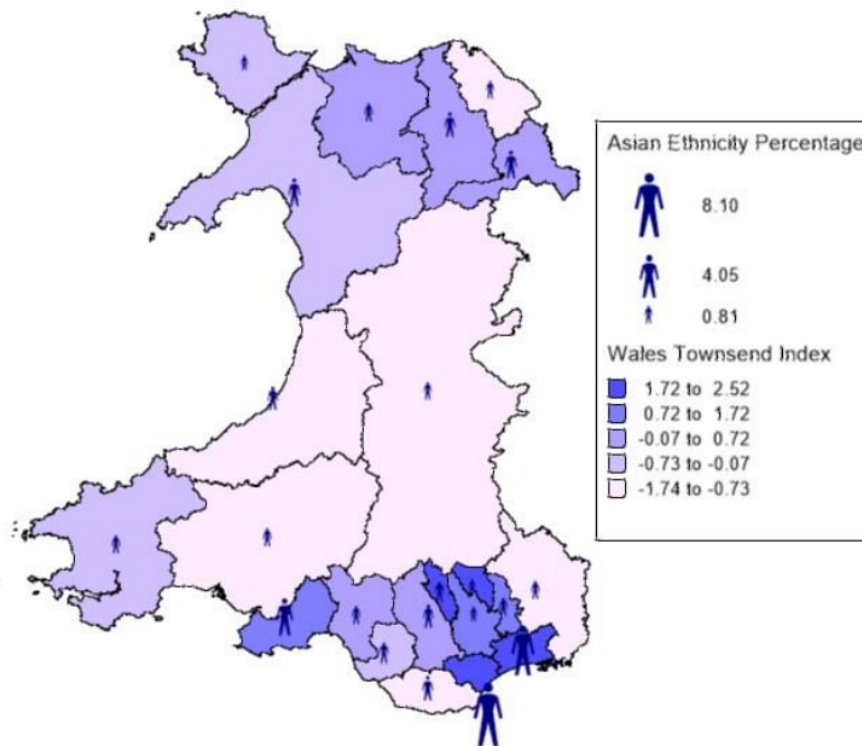


Fig. 36 Deprivation by Asian Ethnicity

Comparing the MMR coverage and Asian ethnicity proportions over the three periods shows that Cardiff continues to show links with deprivation affecting Asian ethnic groups, with Swansea and Newport, while not as low a coverage by comparison, also showing high deprivation with high proportions. However, despite comparable deprivation to Swansea, Wrexham has one of the highest consistent MMR coverage rates in Wales, despite having one of the highest ethnic proportions.

Black Ethnicities

The highest proportion of black ethnicities are also within Cardiff, Newport, and Swansea, indicating that black ethnicities also experience high deprivation. However, Blaenau Gwent has an extremely low proportion (0.14%), comparable to less deprived areas like Anglesey (0.12%) and Powys (0.10%). The Vale of Glamorgan has low deprivation, despite having a high proportion (0.39%).

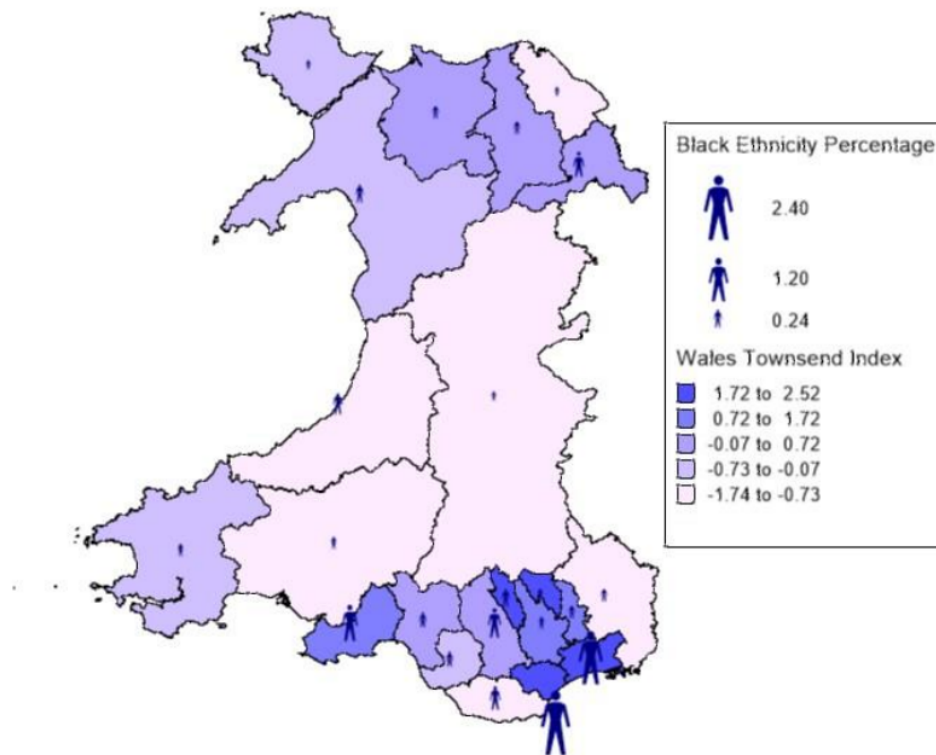


Fig. 37 Deprivation by Black Ethnicity

As with other ethnicities, Cardiff continues to show links between high deprivation, high ethnicity proportions, and low MMR coverage. Swansea and Newport show similar patterns to Cardiff, with high deprivation and higher proportions, though show slightly higher MMR coverage. However, while having lower deprivation levels, Rhondda-Cynon-Taf has consistently high MMR coverage, despite having a higher proportion (0.56%).

Other Ethnicities

The highest proportions continue to be in Cardiff, Newport, and Swansea, though areas like Caerphilly (0.11%), Blaenau Gwent (0.13%) and Torfaen (0.10%) have comparable proportions to less deprived areas like Monmouthshire (0.14%), Powys (0.09%) and Carmarthenshire (0.17%).

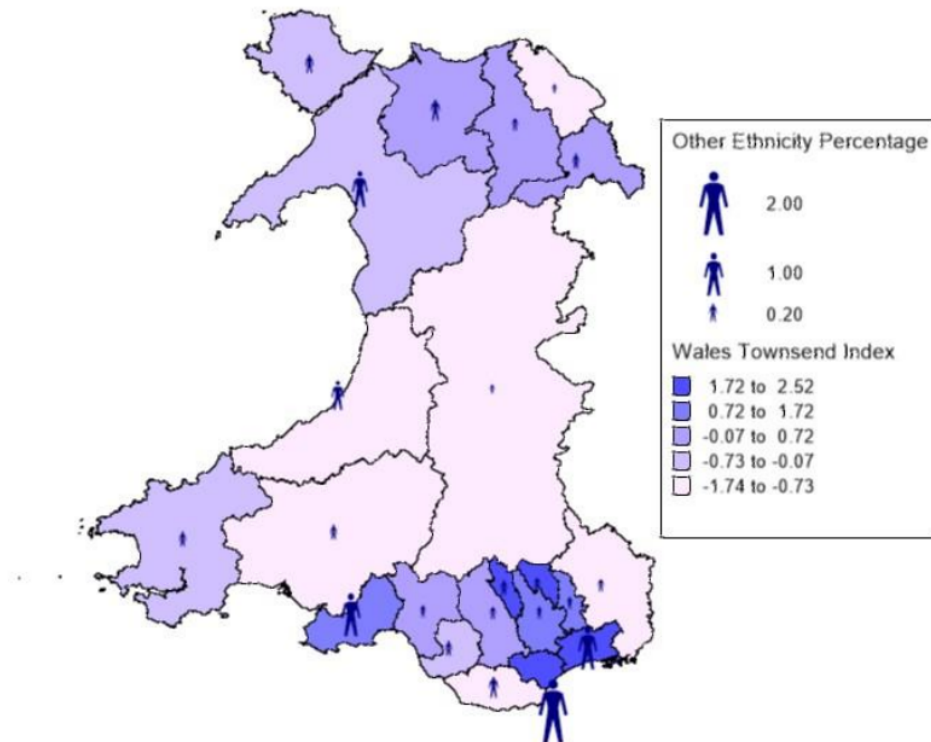


Fig. 38 Deprivation by Other Ethnicity

As before, Cardiff continues to show links between deprivation and other ethnic groups, with Swansea and Newport also continuing to show high deprivation with high proportions. While having higher levels of affluence, Ceredigion has higher proportions of other ethnicities and one of the lowest MMR coverages in Wales.

Overall Results

There is evidence of trends in more built-up areas, whereby Wales's three main cities (Cardiff, Swansea, and Newport) all show high deprivation and the highest ethnicity proportions, suggesting that those in ethnic minority groups will have higher deprivation in these cities and possibly not receiving the MMR vaccination, as the low coverage (especially for the 2nd dose) confirms.

However, conflicting evidence shows affluent areas like Monmouthshire and Powys, despite having extremely low ethnicity proportions compared to other areas, also have low MMR coverages worse than Cardiff, Swansea, and Newport. This is similar for Pembrokeshire and Carmarthenshire, whereby both areas have low deprivation and low ethnicity proportions but have some of the lower MMR coverage rates. The opposite is also evident, whereby areas in North Wales, while not having as high deprivation as the three cities and the South Wales valleys, have high deprivation and higher ethnicity proportions, but consistently had some of the highest MMR coverage rates, suggesting that while some areas like Anglesey and Flintshire are more affluent, have low ethnicity proportions and high MMR coverage rates, it is not consistent with the rest of Wales.

Following these findings, while some areas show patterns between high deprivation, high ethnicity proportions, and low MMR coverage in Wales (as well as low deprivation, low ethnicity proportions, and high MMR coverage), this is inconsistent and while there are some patterns and trends, there is not enough evidence to show that there are significant patterns between deprivation levels, the MMR uptake and ethnic minority groups being disproportionately affected. Therefore, the null hypothesis must be accepted.

Conclusion

While the analysis and findings did not find significant correlations between deprivation and MMR coverage disproportionately affecting ethnic minority groups, there is evidence that there are inequalities within Wales regarding childhood vaccinations, especially in more densely populated areas. This is evidenced by the Inequalities in uptake of routine childhood immunisations in Wales 2022-23 report [19], whereby areas covered by Cardiff and Vale health board were worse for child immunisation rates compared to other health boards, while the most deprived areas within each health board performed the worst, proving that ethnic minority groups are disproportionately affected for general childhood vaccinations.

A recommendation is to consider a public health campaign in Cardiff and Newport, as these areas had continuously low MMR coverage, high deprivation, and the highest proportion of ethnic minority groups, meaning that these ethnic groups may be disproportionately affected as a result.

For future research, demographic data from the 2021 census would be more appropriate when available, as the data will be up-to-date and more accurate, improving decision-making on areas like targeting specific healthcare drives, improving public services, and improving public access to new and existing services.

Extra research could be undertaken on specific local authorities like Cardiff and Newport via the Middle Layer Super Outer Area (MSOA) and Lower Layer Super Outer Area (LSOA), investigating if any areas have low MMR coverages and uptakes, if they are more deprived than others and if they have higher numbers of any ethnic minority groups. This could also be considered for areas like Monmouthshire and Powys where, despite the affluence and lower ethnicity proportions, there continues to be low MMR coverage.

Other research can include the proximity of public services like GP surgeries, as rural areas are less likely to have good access and may need to travel long distances to access services. This could explain the low MMR coverage in areas like Powys and Pembrokeshire due to the rural environment, compared to urban areas like Rhondda-Cynon-Taf and Caerphilly. This can include detailing the GP surgery numbers within an area and the distance to get there, as well as detailing the public transport that is available in these areas.

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Stephen Protheroe-Hewitt Coursework - Submission

GRADEMARK REPORT

FINAL GRADE

82/100

GENERAL COMMENTS

Excellent report layout with a clear introduction of your hypothesis stating your intended direction of study.

Clear documentation of your data acquisition, and how you will be utilising this for your research within this report. It was interesting to look at the ethnicity group data along with deprivation and obviously your chosen MMR analysis.

Overview of all your data cleansing and data preparation for the GIS was given within the initial stages of the report.

Clear analysis of the data has been provided with some excellent map visuals supporting your commentary. It's interesting and alarming to see the drop off in take up of the second MMR, as full protection for children is only provided once they have the booster.

Clear evidence of knowledge of the usage of GIS software to analyse such data sets as can be seen by the excellent maps you have provided throughout with all your different levels of data input into your GIS system.

This is a well written comprehensive report with some interesting data concepts covered throughout. A clear conclusion highlights some of the difficulties faced by health boards when they're trying to promote health policies such as the MMR uptake.

Excellent group participation clear presentation on your direction of study.

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