

VP Geodemographic Analysis Using GIS Software

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Abstract

This report covers a GIS based geodemographic analysis which investigates spatial patterns of socio-economic deprivation, health behaviours and access to primary care services across Wales. This case study used multiple datasets, which were all connected to an MSOA as the primary unit of analysis. The MSOA boundary layer was sourced from the Office for National Statistics Open Geography Portal and was projected into QGIS using the British National Grid coordinate reference system. Choropleth mapping and graduated symbology were applied to assist with the visualisation of the data for analysis, as well as spatial query techniques to identify clusters, overlaps and gaps of services/ across Wales. The thematic mapping reveals a clear concentration of lower income MSOAs in certain parts of Wales, which corresponded with higher BMI rates, greater physical inactivity, elevated disability figures and poorer self-rated health. This supports the primary research questions, that lower income is associated with a reduced adoption of healthy behaviours. The secondary research question was supported by the spatial distribution of GP services across Wales. Rural areas of Wales received less facilities, while urban and high-deprivation areas are well served. This analysis encountered several limitations, including temporal inconsistency, simulated MSOA-level data for BMI and physical activity as none was available at MSOA-level. Additionally, the absence of MSOA mental health service data. This study shows that GIS is an effective tool for identifying where health inequalities exist and recommends further research into other kinds of datasets to strengthen the research (e.g. public transport availability, mental health data etc).

Introduction

Geographical Information Systems (GIS) provide a framework for analysing spatial patterns and relationships between datasets [1]. These systems allow researchers to map out the data to visualise any correlations and relationships in a way that may not immediately be recognised through traditional analysis. This report presents the results of a GIS-based study investigating the spatial distribution of deprivation, health behaviours and access to primary care services across Wales. Using Middle Layer Super Output Areas (MSOA's) as the basis for this visualisation, a myriad of socio-economic and health related datasets have been implemented into QGIS to examine relationships between the variables that are relevant to the two research questions that the team selected.

The study utilises thematic mapping and spatial query techniques to explore whether lower income areas are associated with a reduced adoption of healthy behaviours and poorer health outcomes. The secondary objective that was investigated was if primary care and mental health services are adequately distributed in the areas that may need them more (e.g. lower income, higher BMI, unhealthier areas). By applying the established principles of thematic mapping and spatial data visualisation [2], this report evaluates the patterns of inequalities and accessibility across Wales in a geographical context.

Methodology

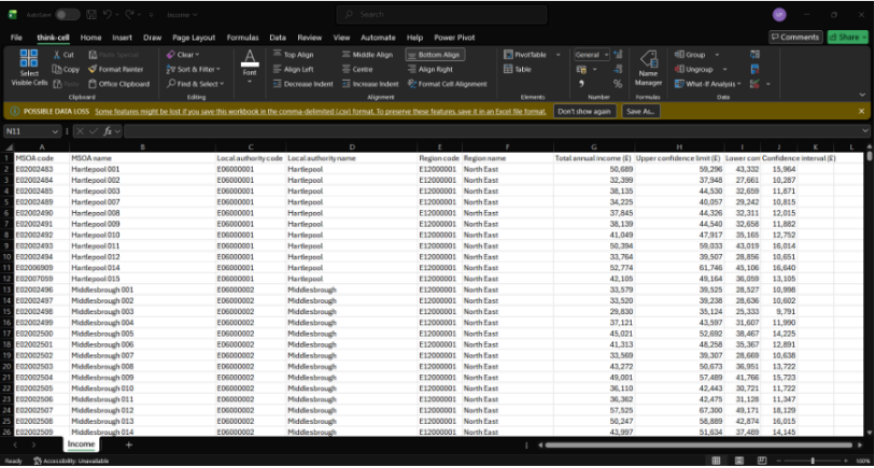
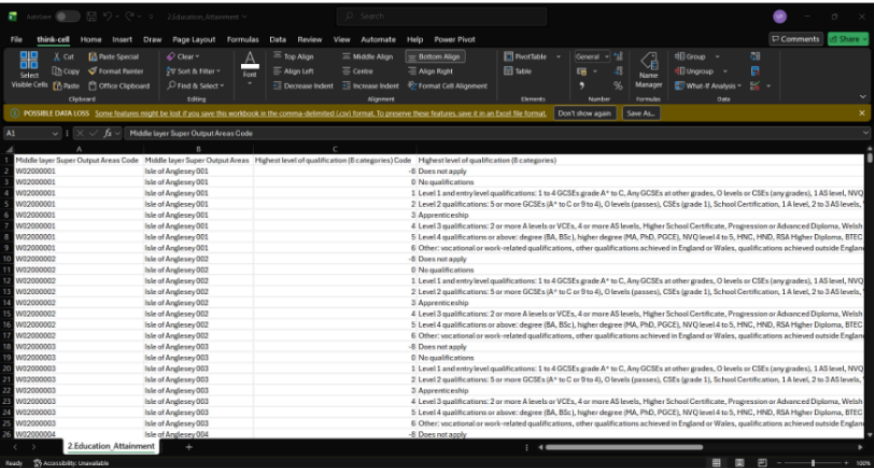
Data Processing

GIS Build

The GIS build process involved the integration of multiple spatial and non-spatial datasets to create a framework to examine the socio-economic and health inequalities across Wales. The primary unit of analysis was the MSOA, which provides a consistent boundary for comparing statistical data. The base layer consisted of an MSOA boundary polygon obtained from the Office for National Statistics Open Geography Portal in a 'shapefile' format. This was integrated into the GIS using the British National Grid coordinate reference system (EPSG:27700) [3]. All other datasets were then joined onto this spatial framework.



Data Collection and Manipulation



latitude and longitude. This means the map can show both area patterns and specific locations at the same time.

As well as data integration, spatial analysis techniques are used to explore the relationships between the datasets. Certain tools, including 'Select by Attribute' and 'Select by Location' can be used to identify clusters, overlaps and gaps in services provided across Wales. These outcomes assisted in supporting the overall research questions and objectives.

Limitations with GIS Build Process

There were several limitations that were encountered while building the GIS map. Certain datasets had data that were collected from different time periods, ranging from 2011 to 2024, which may affect the temporal consistency of the analysis. Additionally, some datasets (particularly those relating to the BMI and physical activity) required a simulated MSOA as there was an absence of directly compatible geographic identifiers [7]. While this assisted with the continuation of the analysis, it introduced some uncertainty regarding the accuracy. This data was still included to support the research but may have been replaced with more accurate information if it was available at the time of this project. Furthermore, the lack of MSOA-level data available for mental health services limited the ability to fully address all aspects of the secondary research question.

Overall, the GIS build process was very successful. The map includes fully integrated datasets into one coherent spatial framework and enables a detailed thematic mapping and analysis.

Thematic Maps

Principles of Thematic Mapping

Thematic mapping is a fundamental technique within GIS which enables the visual representation of spatial variation across defined geographic areas [8]. General reference maps, which prioritise location and orientation, while thematic maps are designed to communicate patterns, relationships and trends easily. In this study, thematic mapping was used to represent socio-economic and health indicators across Wales so that correlations and patterns can be identified easily.

A primary method in this project was choropleth mapping, where geographic areas are shaded according to the value of a particular variable. Choropleth maps are suitable for standardised or rate-based data, such as income levels, health outcomes or proportions of populations exhibiting certain behaviours [9].

An essential consideration in thematic mapping is the classification method used to group data values into categories. Common approaches include equal intervals, quantiles and natural breaks (Jenks). In this project, classification plays a critical role in shaping how patterns are perceived. Natural breaks aim to minimise variance within classes and maximise differences between them, often producing a more natural representation of data distribution. The choice of classification method therefore directly influences the interpretation of spatial patterns [10].

Data Symbolology

Colour selection is another key principle of visualisation. Colour schemes, typically progressing from light to dark, are appropriate for ordered data such as income or health indicators where darker shades often represent higher intensity or severity. Consistency in colour usage across maps is important to avoid confusion and to support comparative analysis across datasets. Poor colour choices can mislead interpretation and reduce the clarity of the map [11].

Maps should be designed so that the most important information is immediately visible, while less critical elements (such as base layers or boundaries) remain subtle. In this project, the MSOA boundary layer serves as a reference framework, while thematic layers (e.g. income deprivation or health outcomes) are emphasised through colour and symbology per map and ensures that outputs are interpretable to a wider audience [12].

Data Normalisation

A further critical concept is data normalisation, particularly when dealing with variables. Raw counts can be misleading when mapped directly, as they do not account for differences in population size between areas. Normalising data, such as expressing values per 1,000 or 100,000 people, allows for fairer comparisons and more accurate representation of spatial patterns.

Thematic Mapping in QGIS

QGIS provides a range of tools for styling layers, applying classification methods, and customising symbology. Features such as graduated colour rendering, layer transparency, and labelling allow users to refine map outputs to effectively communicate patterns. Additionally, QGIS supports the integration of multiple data types, enabling both polygon-based choropleth maps and point-based visualisations to be analysed within the same environment.

Outcomes

This section of the report presents the findings derived from the GIS build, using thematic maps and spatial queries to examine relationships between income deprivation, health behaviours, health outcomes and access to primary care services across Wales. The analysis is structured around the key variables introduced in the dataset, with each subsection supported by map outputs generated in QGIS.

Income Deprivation Patterns

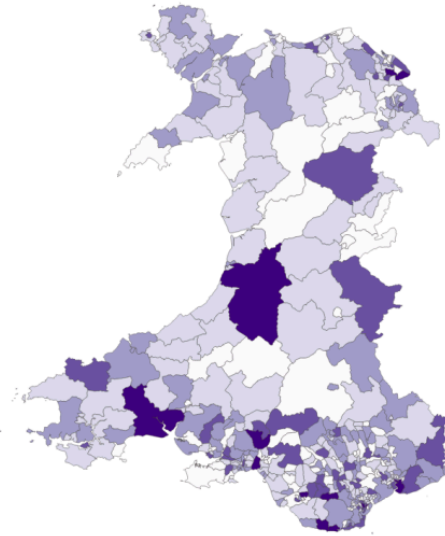


Figure 2: Income Data Map

The choropleth map of income deprivation reveals a clear spatial clustering of lower-income MSOA's, particularly concentrated in parts of South Wales. These areas exhibit consistently darker shading, indicating lower average household income levels compared to other regions. In contrast, more rural and less densely populated areas tend to display higher income levels, although there is evidence of some isolated pockets of deprivation.

This spatial clustering suggests that income deprivation is not randomly distributed but is instead geographically concentrated, reflecting a broader structural inequality. The identification of these clusters provides a foundational layer for subsequent analysis, as income is treated as the primary independent variable influencing health behaviours and outcomes throughout this study.

Education and Income Relationships

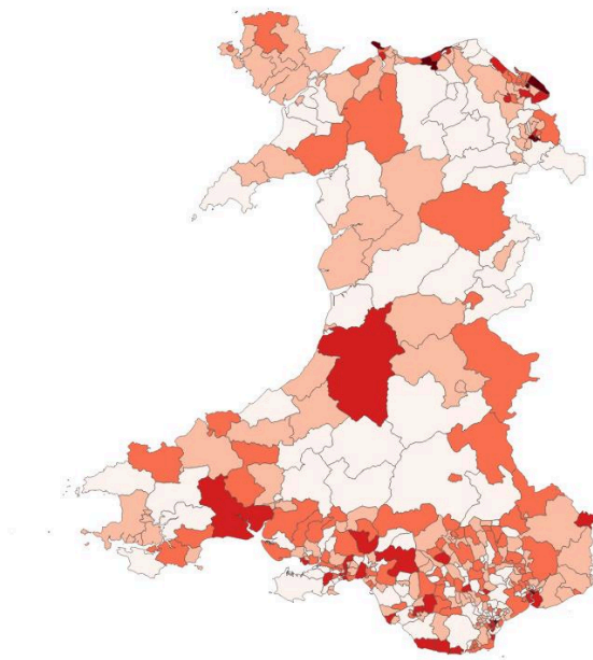


Figure 3: Education Data Map

A comparative analysis between income deprivation and educational attainment demonstrates a noticeable correlation. MSOA's characterised by lower income levels frequently correspond with lower levels of educational attainment, as indicated by higher proportions of residents with minimal or no formal qualifications.

Using spatial query functions such as "Select by Attribute," areas meeting both low-income and low-education criteria were identified. These overlapping areas reinforce the relationship between socio-economic deprivation and a limited access to education, suggesting continued economic disadvantage. However, some exceptions were observed, indicating that the relationship is not uniform across all regions.

Health Behaviours – BMI and Physical Activity

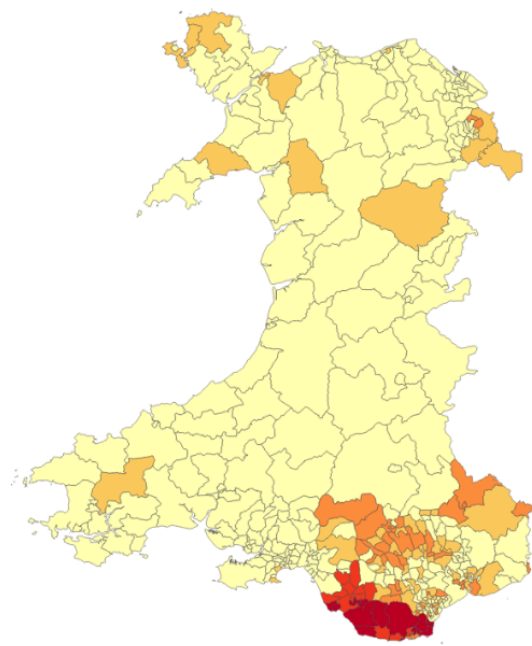


Figure 4: BMI Data Map

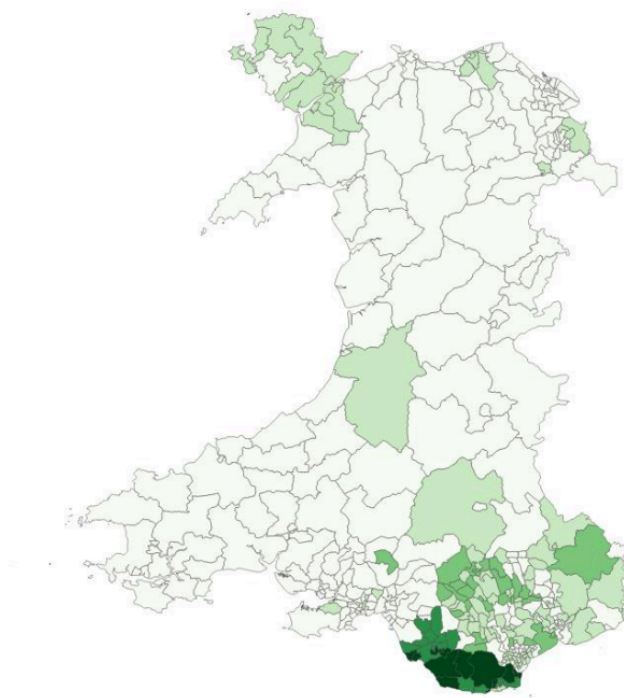


Figure 5: Physical Activity Data Map

The thematic maps representing Body Mass Index (BMI) and physical activity levels highlight further spatial disparities. Areas with higher levels of income deprivation generally correspond to higher average BMI values and lower levels of physical activity. This pattern is not consistent throughout Wales, although the BMI and physical activity do correlate almost identically.

However, it is important to note that the BMI and physical activity datasets were partially simulated to align with MSOA geography. While this was used for spatial analysis to be conducted, the reliability of these findings should be interpreted with caution. Despite this limitation, the overall pattern remains consistent with established research on health inequalities.

Health Outcomes – Disability and Suicide Rates

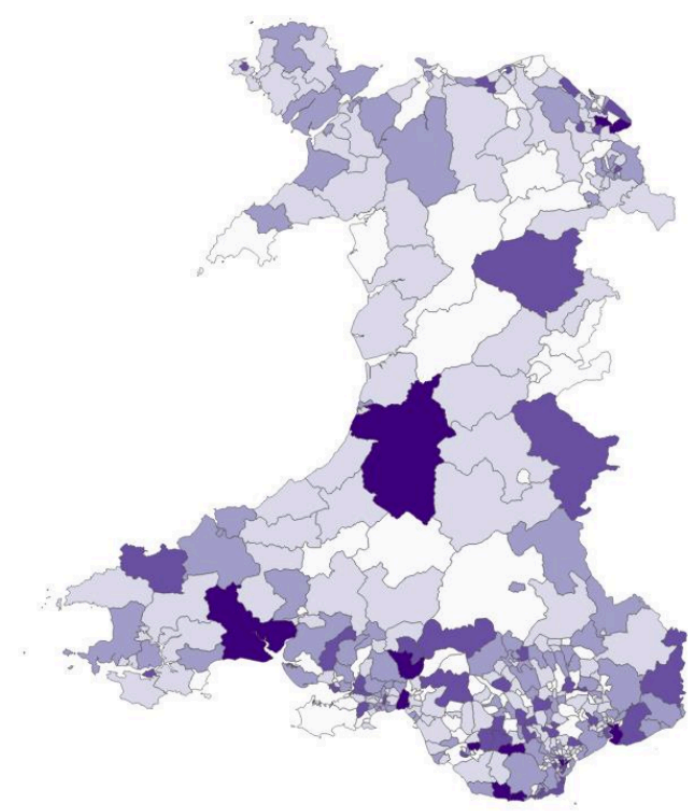


Figure 6: Disability Data Map

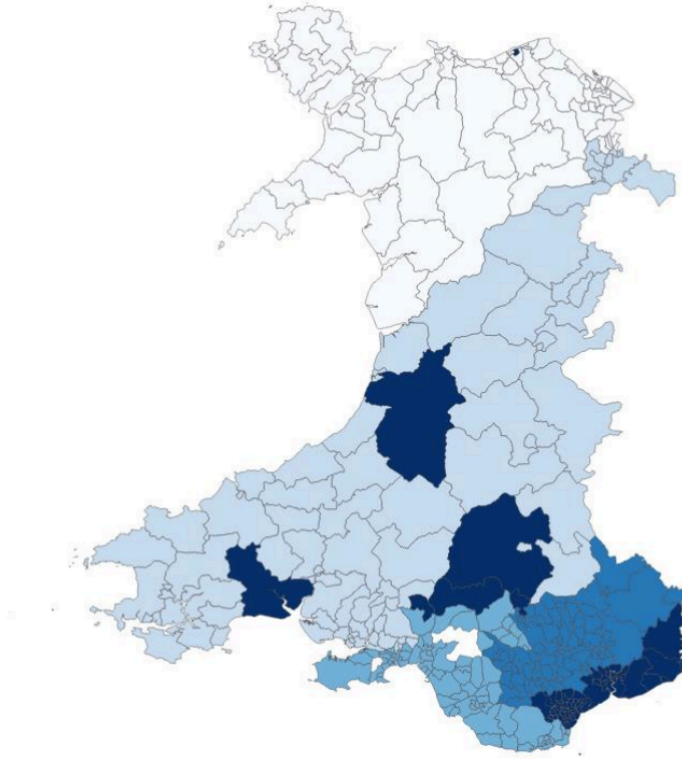


Figure 7: General Health Data Map

Spatial analysis of health outcomes, including disability prevalence and suicide rates, reveals additional layers of complexity. Areas with higher levels of deprivation did show some kind of increased rates of disability and poorer general health. This reinforces the association between socio-economic disadvantage and negative health outcomes.

The distribution of suicide rates, however, presents a less uniform pattern. While some deprived areas exhibit higher rates, other regions with relatively higher income levels also display elevated values. This suggests that suicide is influenced by a broader set of factors beyond income alone, including mental health service accessibility, social isolation, and a multitude of other aspects that may not have data collected (family, living situation, mental health conditions etc). These findings highlight the importance of avoiding overly simplistic interpretations of spatial data.

Accessibility of Primary Care Services

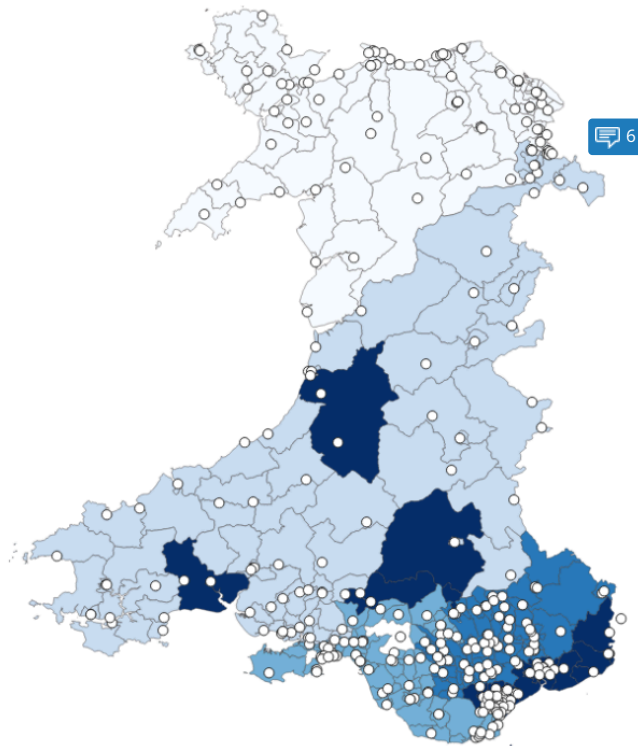


Figure 8: GP Services Data Map

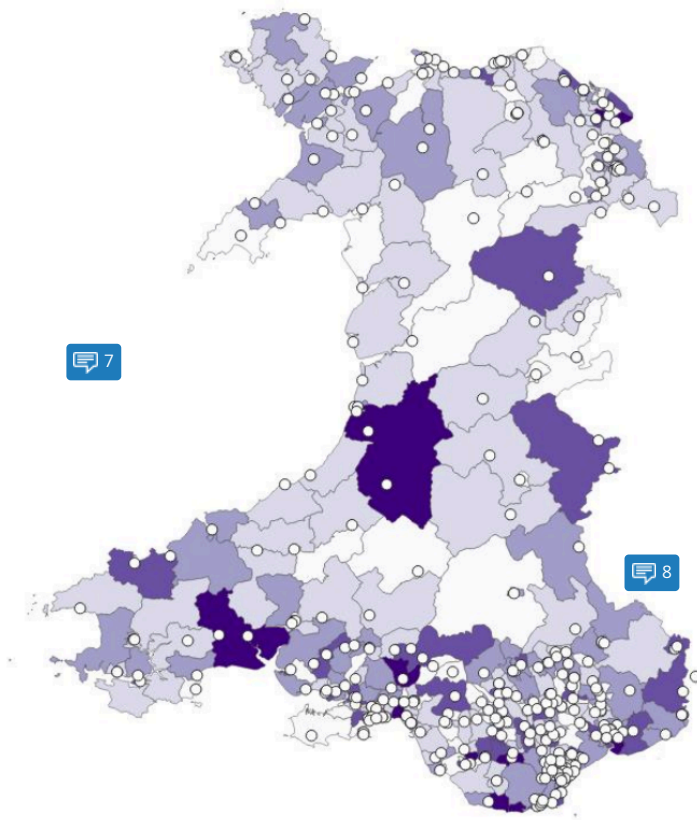


Figure 9: GP Services Data Map – Overlaid on Income Data

The spatial distribution of primary care services was analysed using a point layer representing GP locations. When overlaid with income deprivation data, the results indicate that many urban areas with higher population density, and often higher deprivation, have relatively good access to primary care services. This is reflected in the clustering of GP locations within and around these areas. They may just be due to the population density in those areas.

However, disparities become more apparent in rural regions, where GP locations are more sparsely distributed. Although these areas may not always correspond to the highest levels of deprivation, the increased distance to services suggests potential accessibility challenges. While services are generally present in high-need areas, accessibility is not uniform across all regions.

Analysis

The findings from the spatial analysis  provide strong evidence of a relationship between socio-economic deprivation and health-related outcomes across Wales. The choropleth maps consistently demonstrate that areas characterised by lower income levels tend to exhibit poorer health behaviours, including higher average Body Mass Index (BMI) lower levels of physical activity. This aligns with our primary question, which suggest that economic conditions significantly influence lifestyle choices, access to resources, and overall wellbeing.

In addressing the secondary research question, the analysis indicates a clear spatial correlation between income deprivation and negative health indicators. Areas with lower income not only show reduced educational attainment but also poorer general health and higher levels of disability. This suggests areas with low income also tend to have worse health outcomes, suggesting habitants of these areas require primary care services more. However, the relationship is not entirely uniform, highlighting the influence of additional contextual factors such as local infrastructure, community and environment.

Regarding the primary research question, the distribution of primary care services presents a more complex picture. The analysis of GP locations with deprivation data suggests that, in many urban areas, services are easily accessible in relation to population. This may reflect strategic placement of healthcare facilities in densely populated regions. However, rural areas demonstrate reduced accessibility due to the greater distances to services. While these areas may not always correspond to the highest levels of deprivation, the accessibility to healthcare needs to be reviewed further.

Overall, the analysis suggests that while there is some alignment between service provision and areas of need, there is an inequality in less densely populated areas. These findings emphasise the importance of considering both spatial distribution and location when evaluating healthcare provision. GIS has proven to be an effective tool in uncovering these patterns, allowing for a further understanding in how primary care is spread across Wales.

Limitations

Some limitations included temporal inconsistency within the data, having to use simulated MSOA-level data and the absence of specific types of data.

Realistically, I would've ensured to include data relating to Mental Health and Therapy Services in Wales to dive deeper into if that has any correlation to a higher BMI/poorer

physical activity level. For future research, I would encourage for additional data to be included. Suggestions for additional data include:

- Public Transport Availability
- Mental Health Service Wait Times (if available in the correct format)
- Food Environment Data

All the above data sets could be added for additional insight into how accessible Primary Care services are, additional effects that mental health may have on health and types of food that are available in certain areas (fast food, restaurants, market, farms etc.).

Conclusion

This report has demonstrated the value of Geographic Information Systems in analysing and visualising spatial patterns of socio-economic deprivation, health behaviours, and healthcare accessibility across Wales. By integrating multiple datasets within a GIS environment, it has been possible to identify relationships between income deprivation and negative health outcomes, supporting the hypothesis that lower-income areas are associated with poorer health behaviours and reduced wellbeing.

The analysis also highlights that, while primary care services are often located within or near areas of higher need, accessibility remains uneven, particularly in rural regions. This suggests that service provision cannot be evaluated solely based on location but must also consider other factors including distance and accessibility.

Overall, the study reinforces the importance of spatial analysis in understanding complex social and health inequalities. Future research would benefit from more consistent and granular datasets, as well as the integration of additional analytical techniques, to make future findings more reliable.

Citations

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VP Geodemographic Analysis Using GIS Software

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Dear Victoria,

61 / 100

This is a competent, honest, and practically grounded report that demonstrates real work and understanding of the tools used.

The gap between what was built and what was written about it is the core problem. If the analysis section matched the ambition of the maps, this could comfortably be a strong first-class piece of work.

a more detailed feedback can be found inside the document.

Best Wishes

PAGE 1

PAGE 2



Comment 1 | Transferable Skills(10)

Clear academic structure with all expected sections present

PAGE 3



Comment 2 | Transferable Skills(10)

logical academic structure with all expected sections present

PAGE 4



Comment 3 | Knowledge&Understanding(20)

British National Grid projection (EPSG:27700)and attribute joins explained

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Comment 4 | Knowledge&Understanding(20)

map discussion is largely a restatement of what is visible, without deeper interrogation of *why* those patterns exist spatially

PAGE 12



Comment 5 | Knowledge&Understanding(20)

each visual should be linked back to the research question explicitly

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PAGE 15



Comment 6 | Transferable Skills(10)

figures labelled and referenced within the text rather than just appended

PAGE 16



Comment 7 | Practical Application (20)

GP services overlay on income data is a strong practical decision demonstrating layered analysis



Comment 8 | Practical Application (20)

None of the map outputs contain a visible scale bar, north arrow, or legend. These are fundamental cartographic requirements

PAGE 17



Comment 9 | Transferable Skills(10)

research questions are mixed up between introduction and analysis section



Comment 10 | Cognitive and Intellectual(25)

should discuss what the limitations *mean* for the conclusions

PAGE 18



Comment 11 | Cognitive and Intellectual(25)

propose at least one new research question that the additional data would allow you to investigate



Comment 12 | Literature (25)

Select few key sources and discuss what they actually argue. For example, what does Maguire (1991) say about GIS as a framework? etc.,

PAGE 19



Comment 13 | Literature (25)

Key concepts are all referenced but they

are used as labels, not as discussion

GRADING FORM: GIS

VICTORIA PRICE

61

LITERATURE (25)



12

KNOWLEDGE&UNDERSTANDING(20)



15

COGNITIVE AND INTELLECTUAL(25)



16

PRACTICAL APPLICATION (20)



11

TRANSFERABLE SKILLS(10)



7