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Call Rates, Acuity and Outcomes Across Deprivation Quintiles: A Service Evaluation Using Yorkshire Ambulance Service Data with Embedded Patient and Public Involvement

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Abstract

Background/Objectives: Socioeconomic deprivation is consistently associated with worse health outcomes and unequal access to healthcare in England. Less is known about how deprivation relates to ambulance service use, call acuity and recorded outcomes. Yorkshire Ambulance Service (YAS) NHS Trust introduced NHS Pathways triage into its 999 service during 2025, replacing the Advanced Medical Priority Dispatch System and aligning 999 triage with the tool already in use in NHS 111, providing an opportunity to describe call patterns across the deprivation gradient under a standardised clinical assessment framework. This evaluation aimed to quantify and describe call rates, acuity and recorded outcomes across communities with varying levels of deprivation in Yorkshire, using routine NHS 111 and 999 call data, with embedded Patient and Public Involvement and Engagement (PPIE) to contextualise the findings. **Methods:** Population-based retrospective observational service evaluation using routine YAS operational data on calls assigned an ambulance acuity category (Categories 1–5) from 1 May 2024 to 28 February 2026 (22 months). Of 1,793,254 calls extracted, 1,748,057 (97.5%) could be linked to an Index of Multiple Deprivation (IMD) 2019 national quintile via incident postcode and formed the analytic set. Call rates per 1000 residents per year were calculated using published population estimates aggregated to quintile. Recontact within 24, 48 and 72 h was identified by linking calls sharing an NHS number recorded at the time of the call. Analysis was descriptive and was performed in Microsoft Excel and Python 3.11.15. Two PPIE workshops (Leeds, $n = 12$; Bradford, $n = 7$) were held in March 2026 with 19 participants, after the quantitative analysis was complete. Reporting follows the STROBE statement for cross-sectional studies and the GRIPP2 short-form checklist for the reporting of patient and public involvement. **Results:** The most deprived quintile (Q1) accounted for 688,950 calls (39.4%) and the least deprived (Q5) for 212,803 (12.2%), a crude count ratio of 3.2:1. Q1 contains 30.5% of the catchment population and Q5 15.4%; expressed per head of population, contact was 229.0 against 139.7 calls per 1000 residents per year, a rate ratio of 1.64:1. Callers in Q1 were younger than those in Q5 (median 56 years, IQR 35–76, against 78 years, IQR 59–86). Category 1 calls formed 12.9% of Q1 calls against 9.5% in Q5. Q1 had the highest Hear-and-Treat rate (14.8% vs. 12.1%) and the lowest conveyance rate (53.0% vs. 57.3%); among lower-acuity (Category 3–5) calls, conveyance was 27.9% in Q1 against 37.7% in Q5. Recontact within 72 h was highest in Q1 (15.0%) and lowest in Q4 (13.0%). Outcome distributions were broadly similar under AMPDS and NHS Pathways triage, but the two tools were in use in different periods. **Conclusions:** Ambulance service contact, call acuity and recorded

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outcomes were patterned across the deprivation gradient in this region. The magnitude of the difference in contact depended substantially on whether population denominators were used; a crude count ratio of 3.2:1 corresponded to a rate ratio of 1.64:1 per head of population. Callers in the most deprived quintile were 22 years younger at the median than those in the least deprived, and the absence of standardised and adjusted analyses is a major limitation. PPIE participants contributed contextual perspectives on primary care access and telephone triage, and co-produced seven priority research questions to guide future work.

Keywords: deprivation; Index of Multiple Deprivation; call rates; ambulance services; Yorkshire Ambulance Service; NHS 111; NHS 999; urgent and emergency care; patient and public involvement; service evaluation

1. Introduction

1.1. Background

Socioeconomic deprivation is consistently associated with worse health outcomes and unequal access to healthcare, making health inequalities a persistent challenge for the National Health Service [1,2]. Evidence indicates that deprived communities face both increased demand for and paradoxically reduced effective access to emergency and urgent care services [3], a manifestation of Hart's Inverse Care Law, in which those with the greatest need are least likely to receive adequate care [4,5]. NHS policy aims to address this through frameworks such as Core20PLUS5, which targets the most deprived 20% of the population ('Core20') across five priority clinical areas [6]. Ambulance and urgent care services represent an important point of contact for people in this group, particularly where unmet need and reduced access to primary and preventative care drive demand [5,7]. Examining access and outcomes at the ambulance service level therefore offers direct evidence about whether the urgent and emergency care system is equitably serving this population.

The Yorkshire Ambulance Service (YAS) NHS Trust serves a population of approximately 5.4 million people across a geographically diverse region that includes both highly deprived urban areas and more affluent communities, making it a particularly informative context for this investigation [8].

NHS 111 provides a telephone-based urgent care service, while 999 is the emergency ambulance line. When patients contact either service, call-takers use clinical decision support tools to ensure consistent clinical assessment and appropriate service referral. An example of this decision tool is NHS Pathways, a triage system used nationally throughout NHS 111 and increasingly within 999 services. Yorkshire Ambulance Service introduced NHS Pathways triage into its emergency operations centres during 2025, aligning 999 triage with the tool already in use in its NHS 111 call centres [9]. The adoption of a standardised triage methodology across both services now makes it possible to describe access patterns and outcomes more consistently across the deprivation gradient [10].

A study undertaken in the East of England by Madia et al. [3] found that patients from the most deprived areas were less likely to be referred to the emergency department by a GP (4.7% vs. 14.7%) and correspondingly more likely to arrive by ambulance (32% vs. 24%), with the worst downstream outcomes. Bellamy et al. [11] found that nearly half (47%) of all alcohol-, drug- and suicide-related emergency calls in Yorkshire originated from the most deprived quintile, with call rates more than four times higher than in the least deprived areas. While the association between deprivation and ambulance service use is well established internationally [12,13], a significant proportion of this evidence derives

from non-UK health systems. Furthermore, quantitative analyses of ambulance data rarely incorporate the lived experiences of the communities they describe.

This study therefore combines routine data analysis with Patient and Public Involvement and Engagement (PPIE) to provide both the quantitative evidence and the contextual understanding needed to inform equitable service improvement.

1.2. Aim and Objectives

The aim was to quantify and describe call rates, acuity and recorded outcomes of ambulance calls across communities with varying levels of deprivation in Yorkshire, using routine call data from NHS 111 and 999 services. The following objectives were formulated:

- To describe call rates and acuity across the deprivation quintiles;
- To compare conveyance rates for lower-acuity calls (Categories 3–5) across deprivation quintiles;
- To compare rates of ambulance service re-contact (within 24, 48 and 72 h) across the deprivation quintiles;
- To describe whether outcome patterns across deprivation quintiles differ between calls triaged with the Advanced Medical Priority Dispatch System (AMPDS) and calls triaged with NHS Pathways.

2. Materials and Methods

2.1. Study Design

This is a population-based retrospective observational service evaluation utilising routine operational data from Yorkshire Ambulance Service NHS Trust, complemented by Patient and Public Involvement and Engagement (PPIE) workshops to contextualise the findings. Reporting follows the STROBE statement Table S1 for cross-sectional studies [14] and the GRIPP2 short-form checklist Table S2 for the reporting of patient and public involvement [15].

2.2. Study Setting and Dates

The Yorkshire Ambulance Service NHS Trust provides NHS 111 and 999 services across Yorkshire and the Humber to a catchment population of approximately 5.4 million people. The study used call data covering the 22-month period from 1 May 2024 to 28 February 2026, which included calls triaged using both the Advanced Medical Priority Dispatch System (AMPDS) and NHS Pathways. Data were obtained through the YAS Business Intelligence team and complemented by the Clinical Effectiveness team. Postcode-to-LSOA and LSOA-to-IMD linkage was performed within the Trust before release; no identifiable postcode, patient identifier, name or date of birth was transferred. Catchment population figures used to derive call rates were taken from publicly available mid-year population estimates for lower-layer super output areas, aggregated to IMD 2019 national quintile. No primary data collection from patients or clinicians was undertaken.

2.3. Participants and Eligibility Criteria

All NHS 111 and 999 calls received by YAS within the study period that were assigned an ambulance acuity category (Categories 1–5) and with a valid incident location that could be linked to an IMD 2019 national quintile via incident postcode were included. NHS 111 contacts enter the dataset only where triage resulted in assignment of an ambulance response category. Calls were excluded where the incident location was missing or invalid or could not be indexed, where the call concerned non-emergency patient transport, and where the call originated from healthcare professionals, police officers or fire service per-

sonnel. A total of 1,793,254 calls met the acuity and study period criteria, of which 1,748,057 (97.5%) could be linked to an IMD quintile and formed the analytic set.

2.4. Variables

Deprivation was the principal exposure of interest and was measured using the Index of Multiple Deprivation (IMD) 2019 national quintile linked to the incident location via postcode. Call acuity was categorised from Category 1 (immediately life-threatening) to Category 5 (non-urgent), as assigned by the clinical decision support tool at the point of call. Call outcomes comprised hear and treat, see treat and refer, see treat and convey and no response. No response is the operational disposition recorded when a call is closed without any of the three substantive outcomes being reached: calls terminated by the caller before a response was allocated, duplicate calls relating to an incident already being managed, calls stood down before arrival because the patient was conveyed by another means or the incident resolved, and calls closed administratively. Ethnicity was recorded for only 33–39% of calls and was therefore excluded from analysis.

Recontact was defined as any subsequent call to YAS relating to the same individual within 24, 48 or 72 h of an index call. All eligible calls in the study period were treated as index calls, and subsequent calls were linked to them using the NHS number recorded at the time of the call. Calls for which no usable identifier was recorded could not be linked to an index call and did not contribute to the recontact count, so the rates reported are a lower bound. Recontact rates are expressed with all eligible calls in the relevant quintile as the denominator, as reported in Table 1. A call recontacted within 24 h is also counted within the 48 h and 72 h windows. Call volume per 1000 residents per year was calculated using publicly accessible demographic data aggregated to IMD quintile.

Table 1. Call volume by IMD 2019 national deprivation quintile, with reconciliation of the full extract to the analytic set.

IMD Quintile	Total Calls	Percentage
1 (Most Deprived)	688,950	39.4%
2	307,816	17.6%
3	282,531	16.2%
4	255,957	14.6%
5 (Least Deprived)	212,803	12.2%
Total assigned to an IMD quintile (analytic set)	1,748,057	100.0%
Not assigned to an IMD quintile (excluded)	45,197	2.5% of extract
Total calls extracted	1,793,254	100.0% of extract

2.5. Data Sources and Measurement

All data were extracted from routine operational records held by YAS. No primary data collection from patients or clinicians was undertaken. As an evaluation of routinely collected operational data, this work did not require ethical review under the Health Research Authority decision tool.

2.6. Bias and Confounding

Several potential sources of bias were considered. Ascertainment bias is minimised by the use of a complete extract of all eligible calls within the study period. Misclassification bias is possible where the incident postcode does not reflect the patient's usual residential deprivation context (the ecological fallacy). Because only calls assigned an acuity category were extracted, the analysis is conditional on a call having reached ambulance dispatch triage. Confounding by age, sex, comorbidity burden, geographic service provision and seasonal/temporal factors is acknowledged and discussed under Limitations. The AMPDS

and NHS Pathways data come from different time periods and the triage tool comparison is therefore subject to temporal confounding.

2.7. Study Size

The study size was determined pragmatically by the available data extract for the 22-month period encompassing AMPDS triage and the introduction and adoption of NHS Pathways for 999 calls.

2.8. Statistical Methods

Descriptive statistical analysis was used to summarise the frequency and characteristics of calls, call outcomes, call acuity and recontact rates across deprivation quintiles. Categorical variables are reported as counts, rates and within-quintile percentages. Age is reported as means and as medians with interquartile ranges. Call rates are expressed per 1000 residents per year. Analysis was performed using Microsoft Excel and Python 3.11.15. No imputation was undertaken for missing data. All analyses were conducted on the records with the relevant field recorded, and missingness is reported descriptively: calls that could not be linked to an IMD 2019 quintile are reported as a count and a percentage of the full extract in Table 1 and are excluded from all quintile-stratified analyses, and where any other field was incompletely recorded the denominator used is reported alongside the result.

The dataset constitutes a complete enumeration of all eligible calls received within the study period rather than a sample drawn from a larger population. There is accordingly no sampling error and measures of sampling uncertainty are not reported; the counts, proportions and rates presented are exact descriptions of the population analysed. No hypothesis tests were performed and no *p*-values are reported.

2.9. Patient and Public Involvement and Engagement

PPIE was integrated into the study to ensure that the quantitative findings were contextualised by communities served by the ambulance service. PPIE activities were conducted under the project title "Shaping the Future of Emergency Care Together" and were co-designed with the NIHR Yorkshire & Humber Patient Safety Research Collaboration (PSRC) to involve community members from underserved areas in interpreting the data and shaping future research questions.

Participants were recruited purposively through community partnerships with Leeds Older People's Forum, Healthwatch Leeds and the Wolfson Centre for Applied Health Research, Bradford. Adults aged 18 years or older living in Leeds or Bradford who had personal or household experience of using 111 or 999 services within the previous year were eligible. A £30 voucher was offered to each participant in recognition of their time and contribution.

Two workshops were delivered in March 2026: Workshop 1 (Leeds) on 3 March 2026 at Age UK Leeds with 12 participants (co-facilitated by the lead researcher and the PSRC community engagement lead); Workshop 2 (Bradford) on 11 March 2026 at the Wolfson Centre with 7 participants (facilitated by the lead researcher). Across both workshops, 19 participants were engaged in total. The participant group was diverse and included older adults, a person who had experienced homelessness, a person with a cancer diagnosis, a neurodivergent participant, a participant who was deaf and required lip-reading access, an informal carer, participants from minoritised ethnic communities and a retired healthcare professional.

Participants were sent key study findings and workshop questions in advance to enable preparation, which proved particularly important for participants with accessibility needs. Workshops were structured as facilitated group discussions lasting approximately

90 min. Preliminary quantitative findings were presented visually and participants were invited to respond to a series of open questions covering access to 111 and 999 services, perceptions of barriers to equitable care, and views on priority research questions. Post-workshop evaluation forms were completed by 17 of the 19 participants (89.5%).

The reporting of PPIE activities in this manuscript follows the GRIPP2 short-form checklist [15]. PPIE outputs were used to contextualise the interpretation of the quantitative findings and to co-produce a research agenda; PPIE did not inform the original study design or the analytic plan, which is acknowledged as a limitation.

3. Results

3.1. Call Volume, Rate and Outcome

The dataset comprised 1,793,254 calls over 22 months, of which 1,748,057 (97.5%) could be linked to an IMD 2019 quintile and form the analytic set. Of these, 1,136,391 (65.0%) were triaged using AMPDS and 611,666 (35.0%) using NHS Pathways. The most deprived quintile (Q1) accounted for 688,950 calls (39.4%) while the least deprived quintile (Q5) accounted for 212,803 calls (12.2%), a crude count ratio of 3.2:1 (Table 1). The flow of calls from extraction to the analytic set is shown in Figure 1.

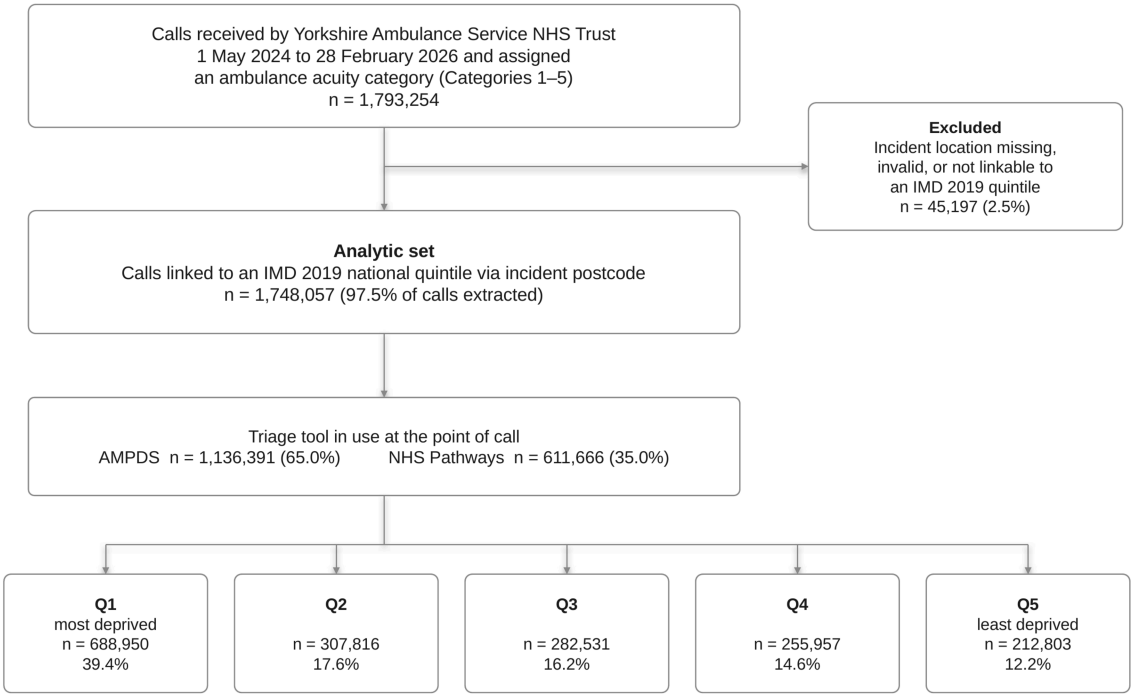


Figure 1. Flow of calls from extraction to the analytic set.

The most deprived quintile contains 30.5% of the catchment population but generated 39.4% of calls. Q1 generated 229.0 calls per 1000 residents per year against 139.7 in Q5, a rate ratio of 1.64:1 and approximately half the crude count ratio of 3.2:1. Rates fall from Q1 (229.0) through Q2 (178.2), Q3 (161.6) and Q4 (137.5), with Q5 (139.7) marginally above Q4 (Table 2).

Q1 had the highest Hear-and-Treat rate (14.8%) and the lowest conveyance rate (53.0%), while Q5 had the highest conveyance rate (57.3%) and a Hear-and-Treat rate of 12.1%, the lowest being in Q3 (11.8%). See, Treat and Refer was relatively consistent across quintiles, ranging from 23.6% (Q5) to 24.7% (Q1) (Table 3).

Table 2. Catchment population, calls and call rates by IMD 2019 national deprivation quintile.

IMD Quintile	Population	% of Catchment Population	Calls (*n*)	% of Calls	Calls per 1000 per Year
Q1 (most deprived)	1,641,212	30.5	688,950	39.4	229.0
Q2	941,987	17.5	307,816	17.6	178.2
Q3	953,847	17.7	282,531	16.2	161.6
Q4	1,015,706	18.9	255,957	14.6	137.5
Q5 (least deprived)	830,874	15.4	212,803	12.2	139.7

Table 3. Call outcomes by IMD deprivation quintile.

IMD	*n*	Hear and Treat	See, Treat, Refer	See, Treat, Convey	No Response
Q1 (most)	688,950	14.8%	24.7%	53.0%	7.5%
Q2	307,816	13.6%	24.0%	54.1%	8.2%
Q3	282,531	11.8%	23.7%	56.6%	7.9%
Q4	255,957	12.7%	24.5%	55.5%	7.3%
Q5 (least)	212,803	12.1%	23.6%	57.3%	7.0%

3.2. Demographics

Callers from Q1 were considerably younger (mean 54.2 years, median 56, IQR 35–76) than those from Q5 (mean 69.6, median 78, IQR 59–86), a difference of 22 years at the median and 15.4 years at the mean. A total of 29.5% of Q1 callers were aged 18–44 compared with 11.2% in Q5, while 45.5% of Q5 callers were aged 80 or older compared with 18.9% in Q1. Females accounted for 51.7% of calls in Q1 rising to 54.3% in Q5 (Tables 4 and 5).

Table 4. Caller age by IMD quintile and sex.

IMD Quintile	Mean Age (Years)	Median Age (IQR)	Female Mean Age	Male Mean Age	Female (%)	Male (%)
Q1 (most deprived)	54.2	56 (35–76)	55.0	53.8	51.7	48.3
Q2	58.5	63 (39–80)	59.8	57.4	52.5	47.5
Q3	63.5	71 (47–83)	64.6	62.6	52.3	47.7
Q4	66.2	75 (53–84)	67.6	64.9	53.0	47.0
Q5 (least deprived)	69.6	78 (59–86)	70.8	69.0	54.3	45.7

Table 5. Age band distribution by IMD quintile.

IMD Quintile	0–17 (%)	18–44 (%)	45–64 (%)	65–79 (%)	80+ (%)
Q1 (most deprived)	7.1	29.5	24.3	20.2	18.9
Q2	6.0	24.3	21.8	22.7	25.2
Q3	5.3	18.0	18.2	25.1	33.5
Q4	5.1	14.5	16.6	25.5	38.2
Q5 (least deprived)	4.6	11.2	14.1	24.5	45.5

3.3. Call Acuity and Conveyance

Category 1 calls were proportionally higher in Q1 (12.9%) than in Q5 (9.5%). Category 3 calls were proportionally higher in Q5 (23.1%) than in Q1 (20.4%) (Table 6). Expressed per head of population, Category 1 calls occurred at approximately 29.5 per 1000 residents per year in Q1 against 13.3 in Q5. Lower-acuity calls (Categories 3–5) accounted for 37.2% of all calls from Q1, 36.8% from Q2, 40.3% from Q3, 38.3% from Q4 and 39.9% from Q5. For lower-acuity calls, conveyance was lowest in Q1 (27.9%) and highest in Q3 (38.2%) and Q5 (37.7%), while Hear-and-Treat ran in the opposite direction (37.8% in Q1 against 29.0% in

Q5). The pattern held under both triage tools—conveyance of Category 3–5 calls was 28.1% in Q1 against 38.3% in Q5 among AMPDS-triaged calls, and 27.5% against 36.4% among NHS Pathways-triaged calls (Table 7).

Table 6. Call acuity distribution by IMD deprivation quintile.

IMD Quintile	Category 1 (%)	Category 2 (%)	Category 3 (%)	Category 4 (%)	Category 5 (%)
Q1 (most deprived)	12.9	49.8	20.4	4.5	12.4
Q2	11.8	51.4	20.8	4.4	11.6
Q3	10.1	49.7	23.9	6.2	10.1
Q4	9.8	51.8	22.3	5.3	10.7
Q5 (least deprived)	9.5	50.6	23.1	6.5	10.3

Table 7. Outcomes for lower-acuity (Category 3–5) calls, by IMD quintile.

IMD Quintile	Calls (*n*)	Hear and Treat (%)	See, Treat and Refer (%)	See, Treat and Convey (%)	No Response (%)
Q1 (most deprived)	256,331	37.8	21.9	27.9	12.4
Q2	113,192	35.3	22.3	28.9	13.5
Q3	113,755	28.0	21.7	38.2	12.1
Q4	98,105	31.7	23.4	33.3	11.7
Q5 (least deprived)	85,021	29.0	22.2	37.7	11.1

3.4. Recontact Rates

Recontact within 72 h of an index call was highest in Q1 (15.0%) and lowest in Q4 (13.0%) (Figure 2).

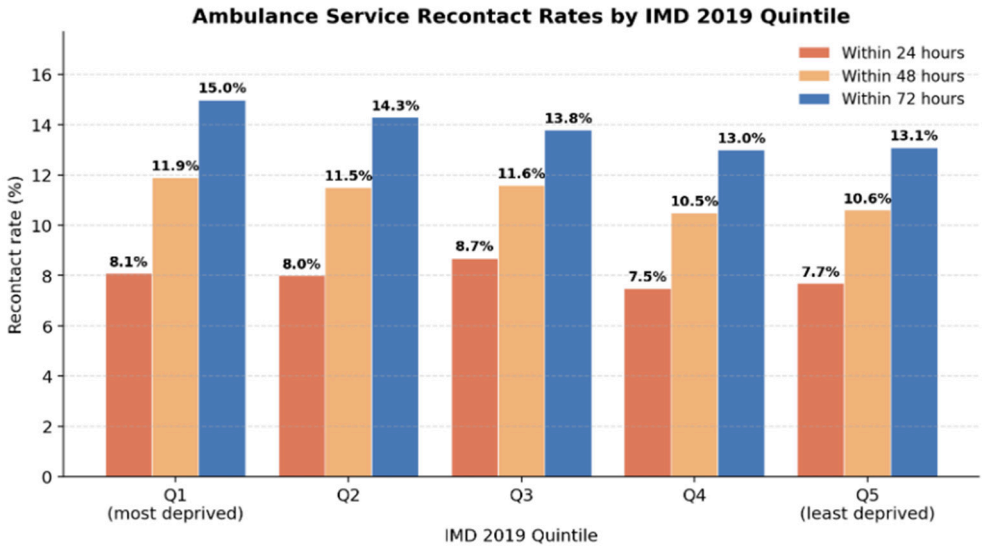


Figure 2. Recontact rates within 24, 48 and 72 h by IMD quintile measured against all eligible calls in the quintile.

3.5. Triage Tool Comparison

AMPDS was the sole triage tool from May 2024 through April 2025. NHS Pathways was introduced in May 2025 and progressively replaced AMPDS through a transition period, becoming the dominant tool by October 2025 and effectively the sole tool by November 2025. Comparison between AMPDS-triaged and NHS Pathways-triaged calls revealed broadly similar outcome distributions. AMPDS had a slightly higher Hear-and-Treat rate (14.0% vs. 12.4%) and lower See, Treat and Refer rate (23.7% vs. 25.3%); conveyance rates

were almost identical (54.6% AMPDS vs. 54.8% Pathways). Both triage tools showed the same lower-acuity conveyance pattern: for Categories 3–5, Q1 had the lowest conveyance rate and Q5 the highest under both systems. Because the two tools were in use in different and largely non-overlapping periods, these figures describe two successive periods of service delivery rather than a comparison of the tools themselves (Table 8).

Table 8. Call outcomes by triage tool.

Triage Tool	Calls (*n*)	Hear and Treat (%)	See, Treat and Refer (%)	See, Treat and Convey (%)	No Response (%)
AMPDS	1,136,391	14.0	23.7	54.6	7.7
NHS Pathways	611,666	12.4	25.3	54.8	7.4

3.6. Co-Produced Research Questions Shaped by PPIE

Across the two workshops, 100% of respondents reported that their views were valued during the session. In Leeds, 89% felt there was sufficient opportunity to ask questions (100% in Bradford), and 89–100% rated the workshop activities as interesting and clearly explained. Qualitative feedback highlighted the value of feeling listened to and the importance of a person-centred, participatory approach.

Participants co-produced seven research questions reflecting community priorities, which provide a foundation for future YAS service evaluation. These were the following:

- Why do people in the most deprived communities use ambulance services as a substitute for primary care, and what primary care interventions would reduce this reliance?
- How does the 111 triage process affect equity of access for neurodivergent callers, people with sensory impairments, and non-English speakers?
- What are the downstream outcomes for non-conveyed patients in deprived areas, and does non-conveyance contribute to recontact?
- Are women using 111 differently from men, and does this contribute to differential ambulance dispatch?
- Does the ambulance service exacerbate or mitigate health inequalities through differential conveyance?
- What training is needed for 111/999 call handlers to provide equitable, diversity-informed triage?
- How has COVID-19 changed ambulance use patterns among younger adults in deprived areas?

4. Discussion

Call rates were inversely related to deprivation, at 229.0 calls per 1000 residents per year in the most deprived quintile against 139.7 in the least deprived, a rate ratio of 1.64. The corresponding ratio of unadjusted call counts between Q1 and Q5 was 3.2:1; because the most deprived quintile contained 30.5% of the catchment population against 15.4% in the least deprived, approximately half of the apparent difference in call volume is attributable to population size rather than to rate of contact. Rates declined across the first four quintiles (229.0, 178.2, 161.6 and 137.5 per 1000 per year) but did not decline further in the least deprived quintile (139.7), so the association is concentrated at the deprived end of the distribution rather than graded uniformly across it. The direction of the gradient is consistent with the Inverse Care Law [4] and with the well-established relationship between socioeconomic deprivation and emergency healthcare utilisation [2,5]. Viewed through Dahlgren and Whitehead's social determinants model [16], the observed pattern is consistent with the downstream expression of upstream determinants such as poverty,

unemployment, poor housing, food insecurity and limited educational opportunity, which create the conditions in which acute illness, mental health crises and substance misuse flourish, and which are in turn associated with demand for emergency services. Marmot [2] describes this as the "causes of the causes"—the structural factors that shape population health long before an individual dials 111 or 999.

Nineteen members of the public took part in two structured workshops after the quantitative analysis was complete. Their contributions were undertaken as involvement activity rather than as qualitative data collection, and are reported here as contextual perspectives on the quantitative findings in accordance with GRIPP2 [15].

PPIE participants provided context for this structural interpretation. A participant who had experienced homelessness explained that without a registered GP, people in their situation must call 999 or 111 for conditions that would otherwise be managed in primary care, including repeat prescriptions. This reflects what Andersen's Behavioural Model [17] describes as an enabling factor: the availability (or absence) of a usual source of care shapes how individuals enter the healthcare system. In deprived communities, the ambulance service may become the de facto point of entry where structural barriers to primary care access are present rather than as a matter of patient preference. This pattern is consistent with published evidence; Cowling et al. found that self-reported difficulty in accessing primary care was associated with increased emergency department attendance in England [5], and Madia et al. found that patients from the most deprived areas were less likely to reach emergency care via general practice referral and correspondingly more likely to arrive by ambulance [3].

A neurodivergent participant described preferring to call for an ambulance rather than navigating what they experienced as a confusing and inaccessible 111 triage pathway. Viewed through Social Cognitive Theory [18], this is consistent with low self-efficacy in navigating complex healthcare systems. Self-efficacy is shaped by prior experience, social modelling and environmental feedback. When the healthcare system is perceived as rigid or poorly adapted to diverse communication needs, individuals may develop low confidence in their ability to navigate it, defaulting to the more immediate 999 pathway.

The 111 triage process relies on the caller's ability to respond to algorithm-driven questions and may systematically disadvantage those with low self-efficacy, limited health literacy, neurodivergent communication styles or sensory impairments. PPIE participants provided vivid illustrations, namely, the deaf participant who could not engage with the telephone system and the neurodivergent participant who found triage questions confusing and bypassed 111 entirely. From a proportionate universalism perspective [19], these findings suggest that services such as 111 and 999 need to be delivered with intensity and flexibility proportionate to the level of disadvantage. A one-size-fits-all triage algorithm, while offering consistency, may inadvertently reproduce health inequalities. These accounts are consistent with the quantitative patterns observed but do not constitute evidence for them.

Caller age differed across the deprivation gradient more than any other characteristic examined. Median caller age was 56 years (IQR 35–76) in the most deprived quintile and 78 years (IQR 59–86) in the least deprived, a difference of 22 years; the corresponding difference in means was 15.4 years (54.2 against 69.6). These distributions are consistent with different patterns of health-seeking behaviour. The Health Belief Model [20] proposes that health behaviour is determined by perceived susceptibility, perceived severity, perceived benefits and barriers, cues to action, and self-efficacy. In deprived communities, several of these constructs operate differently. Perceived susceptibility may be higher—individuals living in conditions of poverty and environmental hazard may perceive themselves as more vulnerable to acute illness. Perceived barriers to alternative care, including difficulty

obtaining GP appointments, unfamiliarity with out-of-hours services, language barriers and digital exclusion, are higher in deprived populations, making the ambulance service the path of least resistance. The age-band distributions describe two different patterns of service use: 45.5% of callers in the least deprived quintile were aged 80 years or over, while 29.5% of callers in the most deprived quintile were aged 18 to 44 years. This distinction corresponds to the socioeconomic gradient in healthy life expectancy, which in England in 2022 to 2024 differed by 19.4 years for males and 20.3 years for females between the most and least deprived deciles [21]. PPIE participants described this, noting that younger people in deprived areas have fewer alternative options and are more likely to use emergency services as a first point of contact.

PPIE participants also noted that since COVID-19, younger people in deprived communities have developed a pattern of calling 999 for a broader range of problems, having been encouraged during the pandemic to stay home and call. This may represent a pandemic-era cue to action that has persisted, creating a cohort effect in health-seeking behaviour. The Transtheoretical Model [22] helps explain why this change has proved persistent: individuals who adopted emergency-service-first behaviour during COVID may remain in a "maintenance" stage, the behaviour reinforced by positive ambulance care experiences. One informal carer described how a delayed diagnosis had led to repeated emergency calls that might have been avoided with timely primary care, illustrating how barriers at one level of the system translate into demand at another.

The proportion of calls in the lower acuity categories did not, however, differ in the direction that is sometimes assumed. Categories 3 to 5 accounted for 37.2% of calls from the most deprived quintile and 39.9% of calls from the least deprived, with the highest proportion in the third quintile (40.3%). The higher rate of contact observed in more deprived areas was therefore not attributable to a disproportionate volume of low-urgency calls. Variation in non-conveyance between and within English ambulance services is also well documented, and O'Cathain et al. identified clinician experience, availability of alternative care pathways and organisational culture as principal determinants, rather than patient characteristics alone [10].

The combination of lower conveyance for lower-acuity calls in Q1 (27.9%) with higher recontact within 72 h (15.0%) raises questions about whether the Inverse Care Law operates not only in access to care, but also in the intensity of care received. Patients from the most deprived communities are often treated on-scene and released without conveyance, and their underlying problems may go unaddressed, resulting in re-presentation within days. The co-occurrence is equally compatible with a younger and more socially precarious population having a lower threshold for renewed contact with an accessible service, and these data cannot distinguish between the two explanations. Through the lens of candidacy theory [23], individuals from deprived backgrounds may be less effective at asserting their candidacy for conveyance, particularly in a system under resource pressure. PPIE participants described situations where callers felt they should have been conveyed but were managed at scene, only to re-present later. These accounts do not establish whether the lower conveyance rate in Q1 reflects appropriate management; that question requires linkage to emergency department, admission and mortality records. From the perspective of the Ottawa Charter for Health Promotion [24], addressing these inequalities means creating supportive environments and reorienting health services towards equity—not merely treating the downstream consequences of deprivation.

Outcome distributions under the two triage systems in use during the study period were similar: Hear-and-Treat was marginally more frequent under AMPDS (14.0% against 12.4%), See, Treat and Refer was marginally more frequent under NHS Pathways (25.3% against 23.7%) and conveyance was almost identical (54.6% against 54.8%). Because AM-

PDS was in sole use until April 2025 and NHS Pathways had effectively replaced it by November 2025, the triage system and calendar period are collinear in these data, and the comparison describes two successive periods of service delivery rather than the properties of either system.

Avenues for further work follow directly from the present analysis. Linkage to emergency department attendance, admission and mortality records would determine whether lower conveyance in more deprived areas is associated with adverse outcomes. A designed qualitative study of the triage encounter, addressing the research questions co-produced by workshop participants, would examine mechanisms that operational data cannot capture.

These findings call for a reorientation of how ambulance service inequalities are understood. The traditional biomedical model is insufficient. A socio-ecological model [25] recognises that ambulance use is shaped by intrapersonal factors (such as self-efficacy and health beliefs), interpersonal factors (such as social networks and caring responsibilities), institutional factors (such as triage algorithms and workforce competency), community factors (such as GP availability) and public policy (such as Core20PLUS5). The findings support the Core20PLUS5 framework and highlight the need for integrated, cross-sectoral approaches to address the drivers of demand for emergency ambulance services in the most deprived communities.

5. Limitations

Several limitations should be considered. The principal analytic limitation is that no result reported here is age-standardised. Because the analysis is a complete enumeration of the eligible calls received, no measure of sampling uncertainty is required in order to describe those calls. The decision not to standardise, however, leaves unresolved whether the gradients reported would persist after adjustment for the markedly different age composition of callers in each quintile. The deprivation gradients observed in call outcomes, including the lower conveyance rates and higher Hear-and-Treat rates in the most deprived quintile, may be partly or fully explained by factors that correlate with deprivation but are not controlled for here. Age and sex are known to independently influence call acuity, presenting complaint and conveyance likelihood, and deprived populations have different demographic profiles that could account for some of the observed variation. Median caller age differed by 22 years between the most and least deprived quintiles, and because age independently determines each of these outcomes, that difference would be expected to produce differences in the same direction as those reported. The comorbidity burden, which is higher in deprived populations, may shape clinical decision-making at the scene in ways not captured by call category alone. Service-level factors, including the local availability of alternative care pathways, GP out-of-hours provision, community mental health services and ambulance response capacity, vary geographically; observed differences in outcomes may therefore reflect differential service provision rather than differential clinical need. Ethnicity was recorded for only 33–39% of calls and was excluded from analysis, representing a significant gap given the importance of ethnicity in understanding health inequalities; disability, first language and housing status are not recorded at all. No analysis plan was pre-registered, although the study population and outcome measures were defined before data extraction, and the ratios highlighted in the Results should therefore be read with the risk of selective emphasis in mind.

Deprivation was assigned at the area level by incident postcode rather than by usual residence, and area-level assignment cannot capture individual circumstances; the IMD 2019 [8] also predates the study period. Of 1,793,254 calls extracted, 45,197 (2.5%) could not be linked to a deprivation quintile and were excluded, and no imputation was undertaken. Such exclusions arise disproportionately where there is no fixed address or where the

location is transient or unconfirmed, so the excluded records may be enriched for the circumstances this evaluation set out to examine. Because only calls assigned an acuity category were extracted, the analysis is also conditional on a call having reached ambulance dispatch triage.

The unit of analysis is the call rather than the individual and, outside the recontact analysis, records were not deduplicated, so the influence of frequent callers cannot be determined. Recontact was detectable only within this service, so re-presentation elsewhere is not captured and the rates reported are a lower bound. Acuity categories are operational dispositions rather than independent assessments of severity. No linkage to emergency department attendance, admission or mortality was available, so the appropriateness of non-conveyance could not be assessed.

The AMPDS and NHS Pathways data come from different time periods, and the triage tool comparison is therefore subject to temporal confounding; observed differences may reflect seasonal or operational variation rather than the triage system itself. Future work should employ multivariable regression modelling, adjusting for age, sex, call nature and temporal factors, to determine whether the association between deprivation and call outcomes persists after accounting for these confounders.

The PPIE workshops, while diverse and rich, captured the perspectives of 19 participants from two cities in Yorkshire, and cannot be considered representative of all communities served by YAS. Recruitment through established community organisations means that those least connected to such networks were least likely to be reached, and the £30 voucher may have influenced who took part. The 22-year difference in median caller age and the 1.64 rate ratio in particular may not be readily transferable to other ambulance services with different population and service models, and the IMD is specific to England, so the values reported are not directly comparable with area-based measures used elsewhere even where the direction of association is. PPIE workshops were conducted after the quantitative analysis, meaning that participants informed interpretation but not study design; future studies should involve community members from the outset. The evaluation also describes only those individuals who contacted 111 or 999; people who reached emergency care by other means, or who did not seek care at all, are not represented, and that balance is known to vary with deprivation [3]. Despite these limitations, the combination of large-scale operational data with contextual perspectives from public involvement is a strength of the evaluation.

6. Conclusions

This evaluation describes a consistent association between area deprivation and the rate, age profile and outcomes of ambulance service contact across Yorkshire. Residents of the most deprived quintile contacted the service at 229.0 calls per 1000 residents per year against 139.7 in the least deprived, a rate ratio of 1.64; callers were 22 years younger at the median; and recontact within 72 h was highest in the most deprived quintile, at 15.0%. PPIE workshops with community members contextualised these patterns, identifying the ambulance service as a substitute for inaccessible primary care, highlighting barriers within the 111 triage system for neurodivergent and sensory-impaired callers, and generating a co-produced research agenda of seven priority questions for future investigation. Participants were clear that the inequalities identified are not primarily the result of ambulance service failures, but reflect wider system deficiencies in primary care access and the social determinants of health.

These findings are descriptive and unadjusted. The analysis establishes that ambulance service activity is unevenly distributed across the deprivation gradient in this region; it

does not quantify the contribution of deprivation independently of population composition, nor does it demonstrate differential clinical management by the service.

The co-produced research questions provide a foundation for the next phase of this work.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/ecm3040034/s1, Table S1: STROBE Statement—Checklist of items that should be included in reports of cross-sectional studies; Table S2: GRIPP2 Short-Form Checklist for Reporting Patient and Public Involvement.

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Institutional Review Board Statement: This work was conducted as a service evaluation of routinely collected operational data held by Yorkshire Ambulance Service NHS Trust and was not classified as research. Data were extracted and aggregated at source by the YAS Business Intelligence team; postcode-to-LSOA and LSOA-to-IMD linkage was performed within the Trust before release, no identifiable postcode, patient identifier, name or date of birth was transferred to the analysis team, and no attempt was made to re-identify individuals. The Patient and Public Involvement and Engagement workshops were conducted as public involvement rather than as research; participants contributed to the interpretation and prioritisation of findings and were not research subjects, no personal data were collected or analysed, and no health information about participants was recorded. Ethical approval for the involvement component was therefore not required, consistent with Health Research Authority and NIHR guidance on public involvement. Participants received written information in advance and took part voluntarily.

Informed Consent Statement: Individual patient consent was not required. The quantitative analysis used routinely collected operational data, with no direct identifiers available.

Data Availability Statement: The data presented in this study are available on request from the corresponding author due to information governance restrictions held by Yorkshire Ambulance Service NHS Trust. Aggregated data summarising the findings reported in this article may be made available subject to Yorkshire Ambulance Service information governance approval. The analysis code is available from the corresponding author on reasonable request.

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Abbreviations

The following abbreviations are used in this manuscript:

AMPDS	Advanced Medical Priority Dispatch System
GRIPP2	Guidance for Reporting Involvement of Patients and the Public, version 2
IMD	Index of Multiple Deprivation
NHS	National Health Service
NIHR	National Institute for Health and Care Research
PPIE	Patient and Public Involvement and Engagement
PSRC	Patient Safety Research Collaboration
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology
YAS	Yorkshire Ambulance Service

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