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ORIGINAL RESEARCH



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Overlooked and under-evidenced: Community health and longterm care service needs, utilization, and costs incurred by people with severe obesity

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Summary

Numbers of people with severe obesity (BMI \geq 40 kg/m²), with need for community health and long-term care (LTC) services, are increasing, but documentation is lacking. We identified individuals with severe obesity known to community health and care professionals in a representative United Kingdom region and used an investigatoradministered questionnaire to record needs and use of community health and LTC services. Data were verified against health and LTC records. Local and published sources informed detailed micro-costing. Twenty-five individuals (15 women) consented, aged 40–87 (mean = 62) years, BMI 40–77 (mean = 55) kg/m²: 20 participants (80%) were housebound. Twenty-two different cross-sector community health and LTC services were used, including community equipment service (n = 23), district nursing (n = 20), occupational therapy (n = 14), and LTC (n = 12). Twenty-four (96%) participants used three or more services, with longest care episode lasting over 14 years. Total annual service costs incurred by participants varied from £2053 to £82 792; mean £26 594 (lower estimate £80 064; mean £22 462/upper estimate \pm 88 870; mean \pm 30 726), with greatest costs being for LTC. Individual costs for equipment (currently provided) and home adaptations (ever provided) ranged widely, from zero to £35 946. Total mean annual costs increased by ascending BMI category, up to BMI 70 kg/m². This study provides a framework with which to inform service provision and economic analysis of weight management interventions. People with severe obesity may need sustained care from multiple community care services.

KEYWORDS

care home, functional limitation, home care, housebound, nursing, occupational therapy

What is already known about this subject?

- The proportion of people with severe obesity (BMI ≥40 kg/m²) has grown more rapidly than other BMI groups since 1995.
- People with severe obesity experience increased functional limitations, and higher rates of care home admission.
- Evidence on community health and long-term care service use by people with severe obesity is lacking.

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- People with severe obesity, particularly the housebound, including those <65 years, used multiple community care services long-term.
- Long-term care, occupational therapy, and district nursing services provided the highest dose of care to participants. Weight management input was limited.
- The greatest costs were for local authority funded services of long-term care and occupational therapy.

1 | INTRODUCTION

General population health surveys indicate that the proportion of people with severe obesity (Body Mass Index (BMI) \geq 40 kg/m²) has grown more rapidly than other BMI groups since 1995.¹ Numbers are increasing internationally.² In England and Scotland adult prevalence rates are 3% and 4%, respectively,^{3,4} with a recent estimate predicting English prevalence would more than double by 2035.⁵ In the United States (US), adult prevalence has already exceeded 9%, with prevalence for women reaching 11.7%.⁶

Total healthcare costs for people with severe obesity are an estimated 50% higher than those of healthy weight individuals.⁷ However, such estimates are unlikely to be comprehensive. People with severe obesity frequently experience functional limitations and long-term conditions,^{8,9} needing skilled input from community-based nursing¹⁰ and allied health professionals (AHPs) such as podiatrists, physiotherapists, and occupational therapists (OTs). Definitions of total healthcare costs vary globally but largely focus on medically oriented services (inpatient, ambulatory and medication).⁷ Just two of the 75 international studies reviewed specifically mentioned nursing, and only one mentioned Allied Health services.⁷

Consistent with this, growing evidence suggests increasing need for long-term care (LTC) for people with severe obesity. LTC services provide formal (paid), ongoing care for individuals with a functional limitation or activity of daily living (ADL) restriction, usually in a nonhospital setting.¹¹ When given at home by professional care staff, care is often supplied as a formal home care 'package of care' (PoC), evolving from more traditional informal (unpaid) provision given by families.¹² Analysis of the English Longitudinal Study of Aging (adults ≥65 years) found people with severe obesity had double the need for formal home care at nearly double the cost, compared with an individual of BMI 23 kg/m^{2,13} Additionally, people with BMI ≥45 kg/m² were nearly six times more likely to use formal home care than those with BMI 18.5–24.9 kg/m^{2.14} For people needing residential care, US nursing homes show a steady rise in admissions for those with severe obesity,¹⁵ with staff from care homes in England and New Zealand reporting similar trends.^{16,17}

LTC systems vary widely by country, with differences around terminology, funding, and accessibility, making discussion at international level complex.^{11,12} However, many LTC systems are experiencing common drivers for change: burgeoning numbers of older people and individuals with non-communicable diseases,¹² including obesity.¹⁸ These drivers impact the sustainability of current systems, prompting evolution.¹⁹ Yet access to robust LTC data can be difficult,¹¹ meaning relevant services are themselves orphan areas of research, hampering effective future service planning.²⁰

The context for this study is Scotland, United Kingdom (UK) where the publicly funded National Health Service (NHS) is largely free at the point of care, based on clinical need. In contrast, LTC services (termed social care in the UK) comprising residential care, home care, and day-care services,^{19,21} have historically been funded by a mix of public & private (largely individual) funding.²² In 2018/19, formal adult social care expenditure for Scotland was £3.8 billion, with 84% funding from the public sector.¹⁹ Public sector social care costs for England reached £26 billion in 2020/1.²¹ Given these costs, a better understanding of service utilization is essential. Responsibility for provision lies with local authorities, who commonly apply thresholds relating to functional status and age (≥65 years), with varying degrees of means testing.²² Devolved government means some differences between the four UK nations, such as free personal and nursing care for adults ≥65 years in Scotland.²² However, in all four countries, adults who meet the relevant needs and means tests are eligible for state-funded care.²²

This study was precipitated by the lead investigator's clinical observations as a district nurse, on care provided by community health and LTC services to people with severe obesity. They found a lack of evidence to support service development and inform person-centred care, particularly for people who are house-bound.^{23,24} This gap prevents fully comprehensive economic costings of obesity's impact, leading to a potential underestimation of the benefits of weight management interventions.²⁵ This then impedes informed decision-making regarding interventions and policies,^{14,25} and hampers service development.¹⁰ The aim of this study was to document individual-level community health and LTC service usage for an exemplar cohort of people with severe obesity. In illustrating the need for, and range of, services used, and costs involved, it highlights a new area for research, signposting hitherto neglected data sources.

2 | METHODS

2.1 | Setting

A Scottish local authority area, broadly representative of the Scottish general population by age and long-term health conditions.²⁶

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2.2 | Participant selection

People with severe obesity are often considered a 'hard-to-reach' population, so purposive sampling was used, with potential participants recruited via community professionals (Figure 1) between February–December 2020. Eligibility criteria were, adults aged 16 years and over, in receipt of care services, able to provide informed consent, and identified as likely to have a BMI \geq 40 kg/m². Due to the undocumented nature of the study population, participant numbers were unclear at the study's outset. Sample size was dictated by balancing study resources with the aim of robustly evidencing exemplar cases and achieving data saturation of the type and scale of services used.

Potential participants were excluded if community professionals deemed them unsuitable due to potential for distress, or safety concerns in their home environment. To indicate the wider number of people with severe obesity using services, community health services and local authority run LTC services were asked to conduct a retrospective caseload 'census' for eligible people. Basic demographic details were collected for these individuals.

2.3 | Study design and data collected

Participants were visited at home by the lead investigator, who obtained written informed consent for participation. Participants' height and weight were measured using specialist scales and alternative height measures if required.²⁷ The investigator then administered a 'Help at Home' questionnaire (see Supporting Information), gathering information on help needed at home. This was based on methods used by Health Survey England to assess formal and informal help needed with Activities of Daily Living (ADLs) and Instrumental Activities of Daily Living.^{13,28} Self-reported use of community health, OT,



FIGURE 1 Services approached for recruitment of participants. (Services in red primarily local authority provided long-term care services; services in blue primarily health provided services; services in purple more mixed/jointly-provided services.)

and social work (SW) covered the preceding 12 months; LTC services (care home and home care PoC) covered the preceding month. Data also included medical equipment and housing adaptations.

Participants' health and LTC records were used to verify selfreported data. Unlike hospital episodes which are typically measured in days, community episodes which frequently involve providing supportive care for long-term conditions, can last months, sometimes years. Due to the potential for poor recall (such as length of care episode), participants agreed that any discrepancies would be resolved by using recorded data.

Participants provided data on both informal (non-paid) care and private paid domestic help, e.g., help with housework or shopping. However, these data were excluded from the present analyses. Data were not collected about any private contributions to participants' care costs, due to the very high degree of comprehensive publicly funded care in Scotland and the difficulty of collecting such potentially intrusive data. Given limited study resources the focus was on largely unevidenced LTC, nursing, and AHP data sources. General practitioner (GP) services were excluded from detailed data collection partly due to added data governance complexity, and the existence of a more developed evidence base.⁷

Data collection coincidentally occurred during the COVID-19 pandemic, necessitating a largely operational approach. This meant minimizing face to face contact, wherever possible undertaking data collection alongside essential care provision, and using NHS-approved COVID-19 mitigation measures, such as personal protective equipment. A subset of participants undertook a semi-structured qualitative interview regarding their experience of services (to be reported elsewhere), with participants who completed both the questionnaire and interview receiving a £10 shopping voucher in appreciation of their time.

2.4 | Data analysis

Electronic community health records clearly documented duration and frequency of visits for health staff by service. Home care PoC schedules were routinely summarized in local authority electronic records when starting or changing provision, providing robust timings. Thus, verified dose of care was calculated for each participant using frequency of contact by duration of contact giving a monthly dose of care (hours) by service (further detail is provided in Supporting Information).

Verifying estimated duration of contact for local authority employed community OT and SW roles was more complex. This was because local authority electronic care records were largely narrative, with no indication of staff time input. It also reflects that other than for intermediate care staff, such as Rapid Response teams, much input is indirect, e.g., sourcing equipment, rather than direct care provision with individuals.²⁹ Little guiding literature exists around estimation of staff time in such roles.²⁹ Common practice in such situations is to consult with experienced professionals for guidance.³⁰

Discussion with local OT Team leads produced three broad time bands of low (<5; median 2.5 h), medium (5–9.9; median 7.5 h), and

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high (10-15; median 12.5 h) hours per week input. The same team leads used their knowledge of the caseload work for participants to allocate participants to low-medium (referred to hereafter as 'low') or medium-high (referred to hereafter as 'high') time bands, allowing a directed sensitivity analysis. A mean staff time estimate was calculated of 5 h for low time band participants and 10 h for high time band participants. These time estimates were then used to calculate the most likely estimated OT costs, used as the base case. For the small number of participants (n = 5) with SW input, no local or published guidance was available. Low time band estimates were therefore applied, to keep costs conservative. OT/SW roles involved largely indirect input in support of both LTC and community health services, therefore, are presented as distinct OT/SW outcomes for clarity.

Local and published sources^{29,31} applying 2019/2020 values, informed a micro-costing of participants' monthly dose of care by service, multiplied by 12 for annual costs. Annual costs for community health, LTC, and OT/SW sectors were combined to give a total annual cost for publicly funded services used by each participant and to calculate mean cost per participant across the sample. Equipment (currently provided) costs and adaptations costs (ever provided) were calculated separately to give a total figure, as these were typically one-off, longer term costs.²⁹ Detailed micro-costing methodology is in Supporting Information.

The costs presented in Results are the base case cost estimates using the mean OT/SW time estimates outlined above. Sensitivity analysis was also undertaken using the lower- and upper-time estimates for OT/SWs (see Table S2 for summary figures), with costs presented accordingly.

Care home costs greatly exceeded maximum home care costs, producing notably different values for the small number of participants in care homes. Therefore, a second sensitivity analysis was undertaken, replacing care home costs with either mean (based on home care users only) or maximum planned home care costs. Maximum home care is arguably more applicable, as admission to care home frequently occurs when care needs exceed that deliverable as a home care PoC. Mean cost quoted in Results is the base case OT/SW costs and original care home costs, unless otherwise stated.

Planned outcomes were descriptive statistics regarding BMI, help received from formal services, type and quantity of help used, and publicly funded cost of services used. Mean costs were stratified by BMI group (40-49, 50-59, 60-69, 70+ kg/m²), age, sex, and Scottish Index of Multiple Deprivation (SIMD) decile (grouped into deciles 1-5 and 6-10, with 1 being most deprived),³² for comparison. Analysis was conducted for all participants and a subgroup consisting of LTC users only. Comparative analysis focused on services providing the most intense dose of care to the greatest number of participants.

2.5 **Ethical considerations**

NHS Research and Development and South East Scotland Ethics service deemed the project service evaluation, with approval from the University of Glasgow Medical, Veterinary and Life Sciences Ethics Committee (Project Number 200180200) as a Doctoral study. The local Caldicott Guardian oversaw data governance approvals.

RESULTS 3

Results are presented in the following categories: Demographics, service utilization, help provided, and costs.

Demographics 3.1

There were 25 participants and 32 non-participants. Reasons for nonparticipation reflected the exclusion criteria and are detailed in Table S3. Participants were 15 women and 10 men (n = 25), aged 40-87 years (mean = 62 years), BMI 40-77 (mean = 55) kg/m², 20 (80%) were housebound, and seven (28%) lived alone. Participants reflected obesity's association with lower socioeconomic status, with 17 (68%) from SIMD deciles 1–5. Key demographics are summarized in Table 1.

3.2 Service utilization

As a group, participants were using 22 different community health and LTC services (Table 2), ranging between 1 and 12 services by participant (mean 7, median 7) (Figure 2A). Twenty-four (96%) participants received three or more services, with 17 (68%) receiving six or more services.

LTC use ranged from 1 to 132 (mean 22) months, four (16%) participants were >5 years, with service still ongoing, OT/SW input was generally episodic (mean 8 months), finishing once equipment, or adaptation, or PoC was provided. However, input varied, including one individual with very long-term input at 62 months, with service still ongoing. District nursing recorded the longest episode at 174 (mean 38) months, with 12 (48%) participants receiving district nursing care for ≥ 2 years, and five (20%) participants for ≥ 5 years. Analysis by ascending BMI group found increasing mean length of episode for DN services alone (Figure 2B).

3.3 Help provided

Local authority-employed care professionals (OT/SW) provided input for housing and adaptations, equipment, welfare support (benefits and grants), and adult support and protection concerns. They also arranged LTC provision, including respite care. Dose of care ranged from 1 h per month (intermediate care OT input) up to 10 h per week (as detailed earlier under Section 2).

Community health services focused on enabling participants to live safely at home by promoting functional status, helping to manage long-term conditions, and direct provision of supportive care (individual service examples are available in Supporting Information). Dose of care ranged from a 0.5 h annual review visit by lymphoedema services

TABLE 1 Participants' demographics

 summary by BMI (kg/m²) group

	ALL	BMI 40-49	BMI 50-59	BMI 60-69	BMI 70+
Number	25	8	9	5	3
Women % (n)	60 (15)	63 (5)	44 (4)	80 (4)	67 (2)
Range BMI (kg/m²)	40-77	40-49	50-57	61-67	70-77
Mean BMI (kg/m²)	55	44	53	64	74
Range age (years)	40-87	41-78	40-87	51-76	46-65
Mean age (years)	62	60	67	61	57
Under 65 years % (n)	56 (14)	50 (4)	44 (4)	80 (4)	67 (2)
Lives alone % (n)	28 (7)	50 (4)	33 (3)	0	0
Housebound % (n)	80 (20)	75 (6)	89 (8)	60 (3)	100 (3)
SIMD ^a 1-5% (n)	68 (17)	75 (6)	44 (4)	80 (4)	100 (3)

^aScottish Index of Multiple Deprivation (1 = most deprived).

TABLE 2 Service utilization of community and long-term care services by participants

Nursing services	Mobility/function	Local authority/long- term care	Support services	Allied Health Professionals	Medical/medication
District nurse (20, 2)	Community equipment store (23)	Community occupational therapist (14, 10)	Wheelchair centre (13)	Podiatry (9, 3)	Community pharmacy delivery service (18)
Tissue viability nurse (4, 1)	Community physiotherapist (including rapid response/ community rehab team) (8, 10) ^b	Local authority funded home care (10, 1)	Continence service (7)	Weight management (dietician, psychologist) (5 ^c , 8)	
Bowel and bladder specialist nurse (1, 2)	Community alarm service (including key safe/falls/ OOH toileting support) (14)	Social work (including housing support/welfare rights team) (9, 5)	Orthotics (6)	Lymphoedema service (10, 2)	
Marie Curie services ^d (1)		Care home (2, 1)	Citizen's advice bureau (1)	Mental health team (CPN/psychiatrist) (5, 5)	
		Day centre (1)	Fire service (assess housing) (1)		
		Bin 'pull out' service (1)	Third sector carer support (1)		

Note: Numbers in brackets = participants currently receiving service or an ongoing support service, italics = additional participants who indicated having received service in the past. Black = Health and Social Care Partnership (HSCP)^a, blue = wider NHS service; grey = third sector; yellow = other statutory services.

^aIncluding independent providers (pharmacies, home care agencies) contracted to provide services to HSCP.

^bIncluding community rehabilitation team/rapid response team/intermediate care (service/team configurations were dynamic during COVID-19 response period).

^cTwo had received treatment in the past year, three were on the waiting list.

^dSpecialist nursing care providing end of life support at home.

up to 5.5 h per week input from district nurses (wound care and twice daily insulin administration).

LTC provision included assistance with ADLs due to functional limitations, notably personal care (washing/dressing/toileting/skincare), mobility, medication, and meal preparation. Two (8%) participants permanently resided in care homes. Home care dose of care ranged from 3.5 h weekly (0.5 h once daily by one carer) up to 36.6 h weekly (2 h daily, plus 4.3 h weekly unplanned out of hours care, all by two carers). Five participants (20%) needed two carers due to moving and handling requirements. Four participants (16%) received the maximum of four planned visits daily, with two (8%) of these participants regularly (weekly or more) having extra, unplanned out of hours care for falls/toileting.

Twelve (48%) participants received LTC provision via local authority services, with a further one (4%) having specialist toileting equipment provided to prevent home care input. Participants using LTC were generally older than those with no LTC (mean 70 and 55 years, respectively), although three (12%) participants receiving



FIGURE 2 (A) Service utilization by total number of services used by participant. (B) Mean length of episode (months) by service/BMI group (kg/m^2) . (C) Total annual care costs (£) by participant by sector. (D) Mean annual care costs (£) by BMI group (kg/m^2) by sector: All participants (All Parts), including sensitivity analysis for BMI 50–59 group by mean home care (HC) costs, maximum home care (HC) costs and original care home costs. (E) Mean annual care costs (£) by sex

LTC were <65 years. Men were \geq 7 years older than women in both groups. Five (20%) participants in the LTC group lived alone, compared with two (8%) in the group with no LTC.

Twenty-four (96%) participants received input from informal carers, ranging from the same as that provided by LTC services to sporadic help with gardening, paying bills, or assistance cutting nails. The range of help provided by informal carers was much broader than that included by home care services, indicating the restriction of home care services to essential care, with informal care 'wrapping round' to fill the gaps, including shopping, housework, and paying bills.

Five (20%) participants had contact with weight management services. Two (8%) participants were receiving treatment, with

another three (12%) on the waiting list, meaning the sample was principally non-treatment seeking. A further eight (32%) indicated engagement with weight management services in the past (Table 2).

3.4 | Costs

Total annual costs for community health, LTC and OT/SW services varied from £2053 to £82 792, mean £26 594 (Table 3). Figure 2C plots individual participant totals broken down by sector, demonstrating the wide range: Nine (36%) participants had costs <£10 000, ten

			Long-term	Community	OT/SW ^c	OT/SW costs	OT/SW ^c	Annual care	Annual care	Annual care			Total equipment/	Length c episode (months)	of
Sex	BMI	Age SIMD	a care costs ^b	health costs	costs lower	base case	costs upper	costs lower	costs base case	costs upper	Equipment	Adaptations	adaptations	LTC DN	OT
Σ	40-44	50-54 1-5	£0	£2053	£0	£0	£0	£2053	£2053	£2053	£866	£6401	£7267	0 17	0
ш	40-44	65-69 1-5	£11 340	£3372	£6072	£12 150	£18 228	£20 784	£26 862	£32 940	£2031	£5354	£7385	9	2 5
Σ	40-44	70+ 1-5	£3213	£2874	£6072	£6072	£6072	£12 159	£12 159	£12 159	£2299	£120	£2419	28 38	0
Σ	40-44	70+ 1-5	£15 984	£8757	£12 144	£24 300	£36 456	£36 885	£49 041	£61 197	£5903	£85	£5988	36 24	с С
ш	45-49	40-44 1-5	£0	£636	£6072	£12 150	£18 228	£6708	£12 786	£18 864	£296	£6	£303	0	0 1
ш	45-49	45-49 1-5	£0	£3978	£540	£540	£540	£4518	£4518	£4518	£389	£177	£566	0	2
ш	45-49	50-54 6-10	£18 144	£2730	£24 300	£36 450	£48 600	£45 174	£57 324	£69 474	£6143	£7948	£14 091	122 83	3 62
ш	45-49	65-69 6-10	£3321	£5148	£0	£0	£0	£8469	£8469	£8469	£115	£85	£200	9 22	0
ш	50-54	40-49 1-5	f0	£190	£6072	£12 150	£18 228	£6262	£12 340	£18 418	£0	£6517	£6517	0	33
Σ	50-54	60-64 6-10	fO	£2525	£12 144	£24 300	£36 456	£14 669	£26 825	£38 981	£4237	£405	£4642	0	4
Σ	50-54	60-64 6-10	£0	£5460	£0	£0	£0	£5460	£5460	£5460	£2320	£412	£2732	0	0
ш	50-54	65-69 6-10	£32 805	£960	£24 300	£36 450	£48 600	£58 065	£70 215	£82 365	£25 495	£10 451	£35 946	132 38	8
Σ	50-54	70+ 1-5	£68 364	£11 700	£0	£0	£0	£80 064	£80 064	£80 064	£8174	£0	£8174	21 21	0 1
Σ	50-54	70+ 1-5	£9017	£3090	£0	£0	£0	£12 107	£12 107	£12 107	£597	£269	£866	108 174	0
Σ	55-59	55-59 6-10	£0	£2808	£0	£0	£0	£2808	£2808	£2808	£2367	£160	£2527	0 29	0
щ	55-59	70+ 6-10	f0	£2457	£0	£0	£0	£2457	£2457	£2457	£0	£0	£0	0	0
ш	55-59	70+ 1-5	£68 364	£2278	£6072	£12 150	£18 228	£76 714	£82 792	£88 870	£7458	£0	£7458	1	1 15
ш	60-64	55-59 1-5	£47 520	£1170	£18 228	£24 300	£30 372	£66 918	£72 990	£79 062	£12 754	£18 626	£31 380	64 159	9 20
Σ	60-64	60-64 1-5	£36 288	£8589	£18 228	£24 300	£30 372	£63 105	£69 177	£75 249	£9524	£15 786	£25 310	2 69	9 40
ш	62-69	50-54 1-5	£0	£432	£6072	£12 150	£18 228	£6504	£12 582	£18 660	£3685	£30 576	£34 261	0	0 18
ш	65-69	55-59 1-5	£0	£1176	£6072	£12 150	£18 228	£7248	£13 326	£19 404	£6163	£11 052	£17 215	0	9 (
ш	62-69	70+ 6-10	£3443	£6530	£0	£0	£0	£9973	£9973	£9973	£5436	£148	£5584	21 52	0
ш	70+	45-49 1-5	f0	£3215	£0	£0	£0	£3215	£3215	£3215	£420	£6226	£6646	0 145	0
Σ	70+	60-64 1-5	£0	£3096	£0	£0	£0	£3096	£3096	£3096	£5908	£6576	£12 484	0	0
ш	70+	65-69 1-5	£0	£72	£6072	£12 150	£18 228	£6144	$\pounds 12 \ 222$	£18 300	£2056	£6814	£8870	0	е (
Mean All	55	62	£12 712	£3412	£6338	£10 470	£14 603	£22 462	£26 594	£30 726	£4585	£5368	£9953	22 38	8
Mean LTC users	51	70	£26,484 ^d	£4767	£9618	£14 681	£19 744	£40 868	£45 931	£50 994	£7161	£4906	£12 067	46 57	7 13
^a Scottish	Index of	Multiple Depriv	ation $(1 = mos)$	t deprived).											

^bCare home or home care package of care (local authority provision). ^cCommunity occupational therapist/social worker base case costs.

^dMean for home care service users only £18 107.

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(40%) participants had costs between £10 000-£49 999, whilst six (24%) participants had costs >£50 000.

Costs by sector (Figure 2D) were highest for LTC services (\pm 3213- \pm 68 364; mean \pm 12 712), followed by OT/SW costs (\pm 540- \pm 36 450; mean \pm 10 470), with lowest costs for community health services (\pm 72- \pm 11 700; mean \pm 3412). Sensitivity analysis applying lowerand upper-time bands for OT/SW staffing costs gave upper estimate total costs of \pm 88 870 (mean \pm 30 726), whilst the lower estimate total costs were \pm 80 064 (mean \pm 22 462) (Table 3; Figures S1A and S1B).

The BMI \geq 70 kg/m² group had fewer participants (n = 3), limiting analysis. It also differed from other BMI groups, with participants sharing the characteristics of severe leg lymphoedema, being mobile at home, and slightly younger (mean age 57 years) (Table 1). BMI groups 40–49 (n = 8), 50–59 (n = 9), 60–69 (n = 5) kg/m² were more mixed in terms of clinical presentation, age, and functional limitations. Greater numbers also enabled better comparisons, making these groups the focus of costing analyses by BMI group.

Mean community healthcare costs were largely similar across the BMI 40–49, 50–59 and 60–69 kg/m² groups at \pm 3496– \pm 3694, with BMI \geq 70 kg/m² costs lower at \pm 2128 (Figure 2D). For all participants, men had more than double the mean community healthcare costs of

women at £5095 versus £2290, respectively (Figure 2E), primarily driven by receiving insulin therapy for diabetes from district nurses. Mean LTC costs for women and men were similar (£12 329 vs. £13 287). Women had higher mean OT/SW costs than men (£12 186 vs. £7897), but the higher mean healthcare costs for men meant total mean costs were similar (£26 805 and £26 279, respectively).

Individual LTC costs for care home residents (£68 364) were nearly double the maximum LTC costs for planned home care services (£36 288). This affected two participants, both in the BMI 50–59 kg/ m² group, skewing mean totals considerably upwards (Figure 2D). Sensitivity analysis replacing care home costs with maximum and mean home care costs (£36 288 and £18 108, respectively) showed an increase in mean LTC costs by ascending BMI group when analysed across all participants (Figure 2D). This increase carried through to total annual mean cost when using maximum home care costs but not mean home care costs. Analysis of LTC users only, intensified costs markedly, such that mean total costs for all LTC users were more than four times that of participants with no LTC use (£45 931 vs. £8745) (Figure 3A). Across all participants, mean annual cost per participant was £26 594, rising to £45 931 for analysis of LTC users only.







FIGURE 3 Mean annual health and long-term care costs (£) (LTC, long-term care; HC, home care costs; max, maximum; yrs, years); (A) long-term care users by BMI group (kg/m²) and participants with no long-term care use; (B) all participants by Scottish Index Multiple Deprivation decile (1 = most deprived); (C) all participants by age group; (D) long-term care users only by age group (years) (40–49 years had no long-term care users hence no data displayed)

Mean LTC costs for participants from SIMD deciles 1-5 (£15 299) were double that for those from SIMD deciles 6-10 (£7214) (Figure 3B), partially driven by care home costs being included in the former. Sensitivity analyses, using mean and maximum home care costs instead, found that even without these, mean LTC costs remained greater for SIMD 1-5 (£9387 using mean home care; £11 526 using maximum home care), although to a lesser extent, with total mean costs more similar for both SIMD groups. In contrast, mean OT/SW costs were higher for SIMD 6-10 than SIMD 1-5 (£12 150 vs. £9680, respectively) largely because these participants had input from both OT & SW.

The proportion of participants using LTC increased by age group, 40-49 years had 0%, 50-59 years had 33%, 60-69 years had 50% and 70+ years had 86%. Again, care home costs, concentrated in the 70+ years group, potentially skewed mean annual LTC costs when analysed as a whole group (Figure 3C). However, analysis of mean cost by LTC users only, found participants aged 50-59 years had the highest mean costs (£32 832) (Figure 3D), combining with high OT/SW costs (£30 375), to give the highest total mean costs (£65 157).

All participants had equipment or home adaptations: 24 (96%) had some or all funded by health or local authority services, with the additional participant sourcing them privately. Specialist, sizeappropriate (often termed bariatric) equipment was used by 19 (76%) participants. Rise-recline chairs to aid participants' mobility were the most common equipment, with 20 chairs among 19 participants. Twelve (60%) of these were heavy duty, another four (20%) were custom made, two (10%) were privately supplied (not included in costs), and two (10%) were standard issue. Equipment costs ranged from £0 to £25 495 by participant (mean £4585 for all, median £2367), with 10 participants having individual costs >£5000.

Housing adaptations ranged from simple bathroom grab rails to full-scale house extensions involving architects and builders, with costs from £0 to £30 576 by participant (mean £5368, median £412). Twelve (48%) participants had individual costs >£5000. Sixteen (64%) participants had access to wet floor showers, 10 (40%) being verifiable adaptations by the local authority or a housing association, two (8%) in care homes, two (8%) privately installed, and two (8%) already existing in properties.

DISCUSSION 4

4.1 Summary of key findings

This study evidences the wide spectrum of community care services, with associated costs, needed to support people with severe obesity living in the community. Utilization of key services, notably community nursing, OT and LTC, was often long-term, and commonly included people aged <65 years. Crucially, the greatest costs were for OT/SW and LTC, principally funded in the UK by local authorities, rather than the NHS. Whilst costs for both LTC and OT/SW input appear large, it is notable that the LTC costs presented are robust and

recurring (mean 22 months), whilst the OT/SW costs contain some uncertainties due to staff time being poorly documented and annualising of shorter episodes (mean 8 months). Economic evaluations of obesity and weight management need to include these wider care costs to ensure completeness. Basic analysis suggests ascending BMI group plays a role in increasing costs, but larger, more sophisticated studies are needed.

Non-essential community health services including podiatry, physiotherapy, mental health, and weight management virtually ceased in-person delivery at the start of the COVID-19 pandemic, shortly after data collection began. Essential services, including district nursing and LTC continued in-person care, albeit with restricted input. This frequently meant participants or informal carers undertook extra tasks such as wound and skin care, meal preparation or medication administration. Therefore, service utilization as documented represented the minimum care provision possible, deemed essential, unable to be deferred or managed remotely. Consequently, despite robust methodology, community health and LTC costs are almost certainly underestimated.

Costs generally reflected patterns of utilization, with three groups broadly definable (Figure 2C): a lower cost group (<£6000) largely using just community health services, a medium cost group (£8000-£13 000) mainly using services from two sectors (community health and LTC, or community health and OT/SW costs) and a higher cost group (£26 000-£82 792) mostly using services across all three sectors of community health, LTC, and OT/SW staff. This raises interesting questions about how severe obesity impacts community service utilization, particularly if, and how, progression occurs from the lower cost group to the higher cost group. Future research could explore how the duration and severity of obesity affect an individual's functional limitations and subsequent need for care. A natural extension could consider the potential of weight management interventions to improve functional status, subsequent need for care and, importantly, quality of life measures.

4.2 Long-term care utilization

The findings support previous evidence from population studies demonstrating that severe obesity is associated with high LTC utilization and costs.^{14,33,34} However, research to date is limited by using older data (2002-10), exclusion of those <65 years, or in care homes, and inclusion of low numbers of people with severe obesity.^{13,14,33,34} This study extends the data by including all adults, with the finding that 56% of all participants and 25% of participants receiving LTC were <65 years. The finding reflects the bidirectional relationship between obesity and disability,³⁵ with prevalence of severe obesity amongst adults with disability being double that of adults without disability (11.8% vs. 5.4%, respectively).³⁶

Increasing prevalence of severe obesity across younger age groups,^{3,4,6} with rapidly rising levels in children³⁷ means consequences of severe obesity may be occurring earlier than previous generations. Additionally, individuals with severe obesity are at increased

often lacking.^{10,39}

risk of a fall or stroke,³⁸ leading to immediate serious functional limitations. Community services need to plan for increasing numbers of adults with severe obesity across all ages, needing LTC care. Currently, appropriate community service provision for this population is

4.3 | Numbers affected

Unfortunately, service pressures prevented some services (notably physiotherapy and podiatry) from responding to the study, rendering census data incomplete. However, weight management and lymphoedema services identified a further 229 (171 and 58, respectively) individuals. The census data indicated that the participants are broadly representative of a wider population using services (Table S4). Indeed, when compared with participants, the higher proportion of nonparticipants with SIMD 1–5, may signal a greater burden of physical and mental illness associated with lower socioeconomic status.⁴⁰ This likely includes acute illness or inability to consent due to cognitive decline or learning disability (both contraindications for participation). Such factors are themselves associated with raised BMI and independently likely to result in increased service utilization and costs,⁴¹ again suggesting that the study findings represent conservative figures.

Further studies are required to establish the number of people with severe obesity who require community health, OT/SW, and LTC services across the life course. General weight recording in primary care is problematically low, with approximately one third of patients having weight recorded annually.⁴² Population surveys struggle to adequately document people with severe obesity.² Consequently, robust data on numbers of community-dwelling individuals with BMI ≥40 kg/m² is lacking. Application of current Scottish BMI ≥40 kg/m² prevalence rates by age and sex,³ to area population data,⁴³ produced an estimate of 4500 people per 100 000 adults for the local authority area sampled. Future research needs to disaggregate the BMI ≥40 kg/m² population into subpopulations,²⁵ given the wide BMI range found in this study, with potential differences in service utilization by ascending BMI group.

4.4 | Role of weight management

Outcomes of poor quality of life⁴⁴ and functional limitations,⁴⁴ with potential for high costs of care over sustained periods as evidenced here, make improving access to weight management interventions essential. Accordingly, the finding of low engagement with NHS weight management services is particularly relevant. This was not explained by eligibility criteria for referral, as all participants exceeded the BMI threshold for weight management referral. The finding is consistent with studies suggesting a complex picture around underutilisation of weight management services by people with severe obesity, including lack of services for housebound individuals and need for improved education of health professionals.²⁴ Census data from the weight management service showed a significantly differing demographic profile from the other groups, being predominantly women

(78%), and markedly younger (mean 46 years) (Table S4). This suggests a different cohort receiving weight management from those receiving community health and LTC services. Consistent with this, a 2018 British Psychological Society report highlights 'an emerging cohort'⁴⁵ of housebound people with BMI \ge 50 kg/m² for which

'healthcare staff are struggling to meet patient need and are unable to provide reasonable alternatives of care'.⁴⁵

The increase in remote weight management services resulting from the COVID-19 pandemic may offer future development potential for this under-served population,⁴⁶ as do the new wave of effective anti-obesity medications.⁴⁷ Importantly for this population, shifting away from a weight-centric approach to one focused on wider person-centred outcomes,⁴⁸ including maintaining or achieving functional independence, potentially holds benefit for both individuals and service providers. Training for community staff, who often have sustained input with individuals, but feel ill-equipped to discuss weight,⁴⁹ could lead to health gains.

4.5 | Strengths and limitations

This study's strength is its robust presentation of real-world evidence, to the authors' knowledge not available elsewhere, of detailed community health, OT/SW, and LTC service utilization and costs. For researchers who may not be familiar with community services, it highlights the type of services that need further research, alongside methodology for micro-costing. Hopefully the resultant visibility of OT, district nursing, and LTC services will encourage further research, ideally through collaboration with practitioners.

A potential limitation is that service usage, and hence costs, were not solely attributable to severe obesity.⁵⁰ Participants had multiple other comorbidities, some related to raised BMI including lymphoedema, stroke, cardiovascular disease and diabetes.³⁸ Other comorbidities appeared independent of raised BMI such as multiple sclerosis, spina bifida and ulcerative colitis. Collecting data on all medical comorbidities was outside the study's scope but, where disclosed by the participant as relevant to the help needed at home, these were noted. This included verifiable data for all participants regarding diabetes status, with nine (36%) having Type 2 diabetes. Notably for LTC services, service utilization is arguably a broad proxy indicator of functional limitation, commonly mediated by presence of an informal carer.³³ Future studies to estimate attributable costs could use regression methods with cohorts of those with and without severe obesity, matched for sex, age, socioeconomic status, and chronic disease.

A further limitation is the small number of participants, limiting examination of associations between variables.

5 | CONCLUSION

People with severe obesity, including those under 65 years, may need multiple, long-term, or episodic, costly inputs from community health,

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OT/SW, and LTC services. This care needs to be recognized in cost of obesity studies and economic analyses of weight management interventions. Service providers need to plan for the specialist needs of this increasing population, particularly the housebound.

AUTHOR CONTRIBUTIONS

Kath Williamson conceived and designed the study, carried out data collection, data analysis and interpretation, and wrote the manuscript. Eleanor Grieve contributed to study design, data analysis and interpretation, and edited the manuscript. David N. Blane supervised data analysis and interpretation and edited the manuscript. Michael E. J. Lean conceived and designed the study, supervised data collection, data analysis and interpretation, and edited the manuscript, All authors were involved in writing the manuscript and had final approval of the submitted and published versions.

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CONFLICT OF INTEREST

No conflict of interest was declared.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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