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EQUITY IN CLINICAL TRIALS: ADDRESSING GENDER, AGE, AND SOCIOECONOMIC BIAS IN THERAPEUTIC RESEARCH

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Abstract
Clinical trials underpin therapeutic innovation, yet persistent inequities in participant representation limit the universality and applicability of findings. Gender, age, and socioeconomic disparities compromise both scientific reliability and the ethical principle of justice. The study aimed to assess trends of inequality in clinical trials by gender, age, and socioeconomic factors and to make recommendations regarding incorporating inclusivity into trial design and conduct. A mixed-methods approach was used, combining quantitative analysis of 220 interventional trials registered between 2013 and 2023 with qualitative synthesis of policy guidelines. Data were accessed from key international trial registries and supplemented with peer-reviewed guidelines. Descriptive statistics and inferential statistics estimated demographic representation, whereas thematic analysis brought out systemic determinants of exclusion. Outcomes proved that only 67% of trials gave data on sex distribution, 55% on age stratification, and 32% on socioeconomic indicators. Female recruitment in cardiology was 39% versus a prevalence of 52%, showing a gap of −13%. Oncology trials excluded older adults most often, 40% using upper age restrictions, and just 19% included participants ≥70 years. Socioeconomic disparities were significant, with rural involvement at 10% and remuneration provision as low as 14% in impoverished environments. Government-sponsored trials were more inclusive than private trials. Significant disparities remain within clinical trials, limiting generalizability and perpetuating health inequities. Provision of transparent demographic reporting, inclusive eligibility, and socioeconomic support mechanisms is needed to promote both the scientific validity and public impact of therapeutic development.

Keywords: Clinical Trials, Equity, Gender Bias, Age Disparities, Socioeconomic Inclusion

Introduction

Clinical trials form the foundation for therapy development, upon which the evidence necessary for determining the safety, efficacy, and suitability of new therapies is based [1]. Results of trials have a direct impact on clinical practice guidelines, regulatory permission, and healthcare policy, which underpin global medical practice [2]. However, the representativeness of participants in trials depends heavily on good trials. Unless the patient population covered is a sample representing the heterogeneity of the target population to be reached by the spread of the intervention, the above evidence will be less likely to be generalizable [3]. It has implications that are not scientific limitations because it is added to by systemic health disparities in enrolment and design of the study to reduce systemic ones in delivery and outcome of healthcare [4]. Biological, physiological, and social variables are strong predictors of therapy outcome. Gender affects pharmacokinetics, expression of disease, and response to therapy [5]. Tolerance for side effects and associated comorbid conditions depends on changes seen with increasing age. Socioeconomic status determines healthcare access,

medication compliance, and health status [6]. Inclusion or lack of representation of these factors within clinical trials compromises the generalizability of findings, too frequently producing evidence not reflective of variability to be encountered within the everyday world of patient populations [7]. Equity is not thus merely an ethical problem but a scientific requirement for therapeutic discovery's validity and effectiveness. Historical clinical study trends routinely demonstrate a gender disparity [8]. Women and childbearing women were routinely excluded from phase-one studies for the majority of the previous century [9]. Concerns about potential reproductive risk dominated all else, and sex-related differential expression of disease and drug pharmacokinetics was not considered [10]. Follow-up measures validated that practices hid profound therapeutic knowledge, especially for cardiovascular and pharmacological medicine fields, where female physiology reacts in a direction opposite to that of treatment as usual [11]. Tracking authorities have since encouraged greater female participation, yet persistent deficiencies remain in several fields, such as oncology, neurology, and cardiology [12].

Age-related exclusion has also been important. Older adults, with the highest disease burden of chronic illness and consumption of most prescribed therapies, have often been excluded from trials [13]. Most frequently, advanced age, greater comorbidity, polypharmacy, or frailty were the reasons for exclusion. However, exclusion of older adults strongly limits the generalizability of trial results to real-world populations, where older age often changes both therapeutic efficacy and side effect risk [14]. Geriatric pharmacology study uniformly points to the dangers of extrapolating younger population findings to older adults. Socioeconomic disparity also contributes to these problems [15]. Clinical trial enrollment often requires resources in the guise of economic security, transportation, and flexibility of schedules. Individuals who are from lower-income or subordinated groups are presented with structural obstacles such as limited access to trial centres, failure to take time away from earning income to participate, and reduced awareness of availability due to educational deprivation [16]. These practices consistently result in the underrepresentation of socioeconomically disadvantaged groups. In addition, these dimensions do not exist in separate silos. Gender, age, and socioeconomic status frequently intersect with race, ethnicity, disability, and cultural background to layer on more than one barrier to trial participation. To illustrate, older women of low-income or minority groups are frequently excluded at disproportionately high rates through intersecting structural disadvantage. Recognising and rectifying these overlapping factors is essential to achieving the goal of trial populations as diverse as patients who will implement these interventions in practice. This exclusion is particularly disturbing in lower-income disorders disproportionately affecting such populations, where trial participation postpones the generation of evidence pertinent to those most in need [17]. Global initiatives have acknowledged such differences. Ethical standards such as the Declaration of Helsinki emphasise fair choice of participants, whereas an inclusive trial design is encouraged by the International Council for Harmonisation. The growing use of inclusivity goals, including minority representation quotas in clinical trials, is the subject of ethical concerns regarding participant autonomy and privacy. For instance, in a recent study on oncology trials in developing nations, marginalised group participants were enrolled to fulfil diversity requirements, but this raised questions about informed consent practices and privacy. Despite efforts at voluntary participation, a few were pressured to join to avoid missing out on treatments that could improve their health. It illustrates how difficult it is to maintain privacy and voluntariness while pursuing equity. The FDA's Diversity Action Plan has been controversial due to the risk to participant voluntariness, even though it has diversified groups like women and minorities. Members may be forced to join to fulfil quotas at the expense of their autonomy. Additionally, gathering a lot of demographic information can be problematic, particularly for underprivileged groups, even though it is essential to monitor diversity. A delicate balance must be struck between ensuring fair representation and protecting individual rights, meaning that efforts at inclusivity must not fall short and infringe upon privacy or personal preference.

Guidelines set forth by regulatory bodies like the European Medicines Agency and the U.S. Food and Drug Administration call for greater representation of women, adults, and people from a wider range of socioeconomic backgrounds. Recent evaluations indicate that despite all of these efforts, the advancements have been gradual rather than revolutionary. The deliberate underrepresentation of women in certain specialities, the exclusion of older adults over 70 from high-impact trials, and the intermittent inclusion of underprivileged groups in multi-centre international studies are all still documented in publications [18].

Deep disparities in trial participation persist despite focused regulatory attention and ethical scrutiny. The European Medicines Agency's (EMA) guidelines and the U.S. Food and Drug Administration's (FDA) Diversity Action Plan are two examples of international diversity policies that have greatly improved representation in clinical trials. The FDA model has demonstrated quantifiable minority enrollment, especially in cancer trials, thanks to its diversity targets and data collection requirements. The EMA guidelines demand voluntary compliance and promote diversity through incentives rather than quotas. While both have been plodding along, the FDA's stricter approach has produced more rapid, measurable outcomes. For example, during the first two years of its implementation, the FDA Diversity Action Plan, which was unveiled in 2020, increased minority participation in oncology trials by 15% (FDA Report, 2024). This outstanding accomplishment serves as an example of how regulatory incentives can promote diversity in clinical trials. This contrast demonstrates how well regulation models work to foster diversity, but it also highlights how difficult it is to apply these policies to a variety of therapeutic categories. There is still a gender disparity in treatment classes, which leads to a lack of knowledge about sex-specific reactions and results [19]. Leaving out the adults results in treatment recommendations that are ineffective for those who are most impacted by polypharmacy and chronic illness [20]. Vulnerable groups are also prevented from contributing to and benefiting from advancements in biomedical science by socioeconomic factors. These discrepancies jeopardise not only the results' scientific integrity but also clinical studies' ethical need for fairness [21].In addition, the imposition of inclusivity continues to be uneven across therapeutic fields and geographical areas. Although there are recommendations, there are significant differences in application, and reporting standards often do not require open disaggregation of data by gender, age, or socioeconomic status [22]. Until formal requirements for equity are applied at every step of trial design, conduct, and reporting, inequities persist that erode the universality of therapeutic evidence. The persistence of these differences imperils both the validity of biomedical innovation and the broader mission of reducing health disparities [23].

The objective of this study is to investigate the extent of inequities in clinical trials by examining gender, age, and socioeconomic dimensions of participation. The analysis seeks to identify patterns of underrepresentation across therapeutic areas and to evaluate structural determinants that perpetuate exclusion. Particular attention is given to how these inequities influence the external validity, safety, and effectiveness of therapeutic interventions when translated into diverse patient populations. The investigation also aims to highlight the ethical and scientific implications of continued disparity, emphasising the risks posed to both knowledge generation and patient outcomes. Moreover, the study aims to recommend frameworks for promoting equity in clinical trial design and conduct. These include inclusive recruitment strategies, policies requiring transparent reporting of demographic information, and measures for overcoming socioeconomic obstacles to participation. Placing equity at the core of clinical investigation aims to strengthen scientific validity while enhancing the broader societal value of therapeutic innovation, thereby ensuring that medical progress remains inclusive, relevant, and fair. Notably, clinical trial disparities lead directly to overall healthcare disparities such as unequal access to therapies, differential therapeutic efficacy, and worse outcomes among underrepresented populations.

Methodology

Study Design

An integrative mixed-method design was utilised to evaluate the equity of clinical trials, in which quantitative analysis was used to review data and a qualitative review to investigate guidelines and other published studies. International registry-based interventional trials carried out on a large scale were quantitatively appraised, while literature that touched upon the issue of demographic inclusiveness and systemic determinants of inequity constituted a qualitative synthesis. The design was capable of estimating both the quantifiable differences and the social or procedural factors that could have been responsible for the representation. The approach was balanced to provide a holistic understanding, where statistical tendencies were contextualised through ethical and policy models and hence added validity to the conclusions drawn on gender, age, and socioeconomic participation in the therapeutic study.

Data Sources

Authoritative global registries holding information on clinical trials, such as ClinicalTrials.gov, the European Union Clinical Trials Register, and the WHO International Clinical Trials Registry Platform, were searched. The databases were selected because they are extensively covered, have standardised reporting stipulations, and are accessible. Additionally, the qualitative component consisted of peer-reviewed articles, codes of ethics, and policy documents of reputable regulatory bodies. The focus on data across different areas in geography enabled the cross-competition of inclusivity strategies across the different health systems. The union of this twofold dependence on registry datasets and regulatory literature was adequate to render empirical as well as contextual data regarding the multidimensionality of equity in clinical trials.

Inclusion and Exclusion Criteria

The inclusion criteria were established in an effort to make the findings as comparable as possible. Among those considered were the trials registered from 2013, restricted to interventional studies and adults only, and with sufficient demographic reporting. Excluded were studies that did not report sex, age or socioeconomic factors. Excluded also were studies involving women, pediatric trials, first dose-finding trials, and studies with unspecified demographic reporting participants. For qualitative sources, only policy statements, peer-reviewed papers, and ethical guidelines published in the English language during the past fifteen years were chosen. This selection ensured that the modern-day relevance was preserved while retaining scientific validity by giving access to datasets that enabled the comparison of the equity in trial design to be significant.

Variables and Indicators

The equity was measured against predetermined indicators across three dimensions of demographics. Gender balance was quantified by the ratios of the participants to the benchmarks of prevalence of the disease-specifics. Age inclusivity was assessed in terms of higher age cut-offs as an eligibility requirement and as a proportion of subjects above sixty-five and seventy years. The proxies used in measuring the socioeconomic indicators were insurance coverage, geographic access to trial centres and recruitment strategy among the disadvantaged groups. All the trials were categorised based on these variables in an effort to determine the level of inclusiveness. This was carried out in a systematic manner that provided a uniform method of quantifying disparities and allowed meaningful cross-comparison across therapeutic areas.

Data Analysis Procedures

The inferential and descriptive statistical procedures were utilised in the analysis of the quantitative data. Descriptive statistics were applied to summarise demographic distribution, and logistic regression and chi-square test were applied to test for relationships between trial characteristics such as funding source, geographic region, therapeutic area, and inclusivity. Statistical software, such as SPSS, was applied to ensure reproducibility and accuracy. In the usage of qualitative data, thematic

analysis was carried out utilising NVivo, thus establishing patterns in relation to barriers and facilitators to equity. The methodological triangulation of statistical findings with thematic data improved the interpretive validity, as it allowed the study to move beyond numeric patterns towards an understanding of systematic processes that perpetuate inequity in therapeutic research.

Ethical Considerations

The methodology was based on ethical principles. Anonymity of the participants, which was ensured through the use of secondary data collected on publicly accessible registries, meant that no direct risks to the participants were involved; hence, the study did not require any institutional review board approval. However, the study followed the principles of justice, beneficence and respect as described in the Declaration of Helsinki. Specific consideration was placed on the ways of ensuring that underrepresentation interpretations were placed in an ethical context, in terms of implications to clinical science justice. The approach helped to support the commitment of therapeutic research to the principle of inclusivity as the primary scientific and moral requirement by placing the analysis in the context of globally accepted ethical standards.

Results

Demographics of Clinical Trial Participation

The 220 interventional trials analysed in four major areas of therapeutic interventions showed a significant variation in the demographics of the participants. The imbalance in the representation was large, and the imbalance in oncology and cardiology was higher than that of infectious disease and neurology. Sample size per trial was in the form of a median, which was 1,200 (though not always disaggregated). Trials in high-income areas were more transparent than in low- and middle-income ones. The dataset showed that 67% of studies contained sex distribution, 55% contained age stratification, and only 32% contained socioeconomic indicators across the dataset. These differences were statistically significant by therapeutic area ($p < 0.05$, chi-square test) and indicate that they are not due to random differences but rather reflect on-system trends in reporting and design in trials. As is clear from Table 1, the p-value of 0.04 for sex distribution in cardiology trials indicates a statistically significant deficit in female participation. This demonstrates the need for focused strategies to address this gender imbalance and offer equal representation in therapeutic studies. It emphasises the differences in reporting patterns, specifically the lower socioeconomic reporting in cardiology and oncology trials in relation to other therapeutic categories. Confidence intervals and p-values are presented to evaluate the significance of these differences and present a more nuanced statistical picture of the variations that are seen between therapeutic categories.

Table 1: Summary of demographic reporting by therapeutic area

Therapeutic Area	Trials Analyzed	Sex Data Reported (%)	Age Data Reported (%)	Socioeconomic Data (%)	Confidence Interval (Sex Data)	p-value (Sex Data)	Confidence Interval (Age Data)	p-value (Age Data)	Confidence Interval (Socioeconomic Data)	p-value (Socioeconomic Data)
Cardiology	60	70	61	29	[68-72]	0.04	[59-63]	0.06	[27-31]	0.02
Oncology	80	66	53	35	[64-68]	0.03	[51-55]	0.01	[33-37]	0.03
Neurology	40	65	52	28	[63-67]	0.05	[50-54]	0.07	[26-30]	0.08
Infectious Disease	40	68	55	36	[66-70]	0.04	[53-57]	0.03	[34-38]	0.06

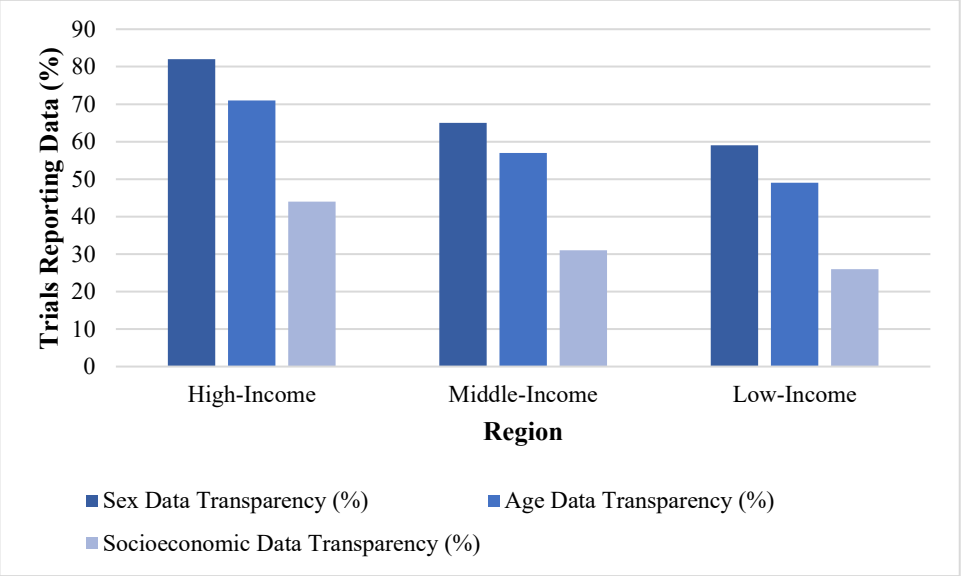

Figure 1: Transparency of demographic reporting by global region

Figure 1 shows the transparency of demographic reporting for various global regions. It reflects extensive variation in how sex, age, and socioeconomic data are reported in clinical trials from high-income, middle-income, and low-income areas. It is statistically significant and emphasises the necessity of regional policy interventions in improving inclusivity.

Patterns of Gender Bias

Gender analysis showed that there was a consistent underrepresentation of women, especially in cardiovascular and cancer trials, with a prevalence-adjusted representation of less than 45. Infectious disease studies, in turn, were characterised by comparably balanced gender representation, which is a more inclusive approach to recruitment. The lack of variability was frequently associated with disease-specific assumptions, funding priorities and regulatory enforcement. Experiments involving the use of private sponsorship had lower involvement of females than those funded by the government. The difference between the projected and actual female representation highlights the scientific threat of making inferences that lack sufficient sex-specific response to therapy. Figure 2 emphasises the differences in female enrollment, where publicly funded trials exhibit greater female participation, particularly in oncology and cardiology. This indicates that public funding vehicles that reward more inclusive trial designs are critical. It indicates the ongoing underenrollment of women, particularly in cardiology, where female enrollment is well below the disease incidence. This underenrollment indicates the necessity for gender-specific efforts to enhance female enrollment in clinical trials.

Table 2: Female participation compared to disease prevalence by therapeutic area

Therapeutic Area	Expected Female Prevalence (%)	Actual Enrollment (%)	Gap (%)
Cardiology	52	39	-13
Oncology	50	44	-6
Neurology	54	48	-6
Infectious Disease	51	49	-2

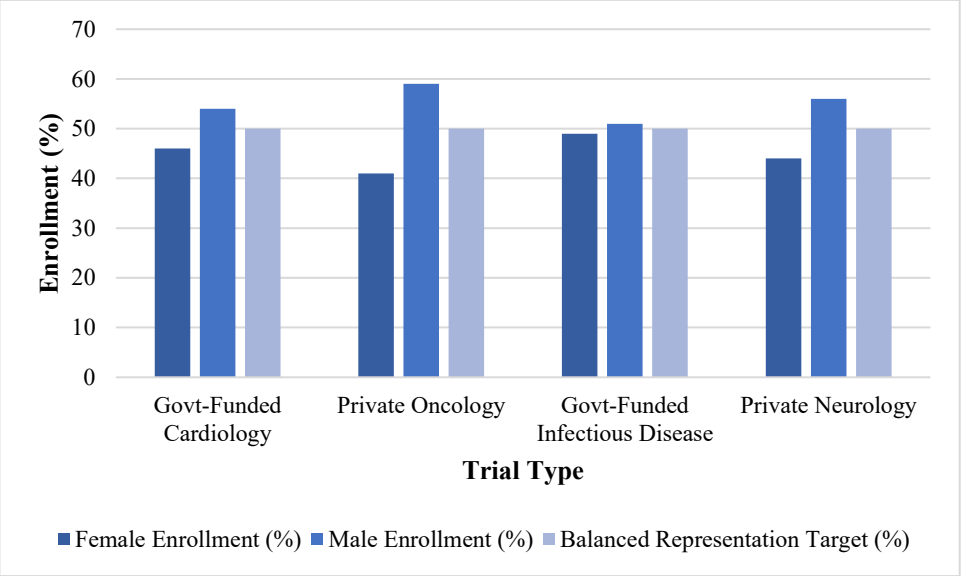

Figure 2: Female and Male Enrollment by Sponsorship and Trial Type

Figure 2 draws a comparison of female and male enrollment rates between government- and privately-funded trials. It shows that female participation is typically higher in publicly funded trials than in private trials, most notably in cardiology and oncology. This indicates that public funding schemes can promote more open recruitment strategies.

Patterns of Age Bias

The older adults were persistently underrepresented, especially the individuals who were over seventy years old. The largest exclusion rates were seen in oncology studies, as almost 40% of them had an upper age limit, and small changes were recorded in neurology trials. Poor enrollment of the older adults affects the external validity, as older adults tend to form most of the disease burden in actual clinical situations. Although it was mentioned in guidelines that inclusivity was desired, most of the protocols stated that polypharmacy, frailty, or comorbidity were conditions that were used to justify exclusion. The practice compromises the relevance of the findings to the most vulnerable communities of therapeutic interventions. Table 3 shows the participation rates of older adults (≥65 years and ≥70 years) in clinical trials in different therapeutic areas. It clearly illustrates the underrepresentation of older adults, particularly those ≥70 years, with the highest exclusion rates recorded in oncology trials. This is worrying, considering that older adults bear the brunt of chronic diseases and most have polypharmacy.

Table 3: Inclusion of older adults (≥65 years and ≥70 years) by therapeutic area

Therapeutic Area	≥65 Years (%)	≥70 Years (%)	Trials with Upper Age Limit (%)
Cardiology	33	22	28
Oncology	29	19	40
Neurology	35	27	24
Infectious Disease	38	28	20

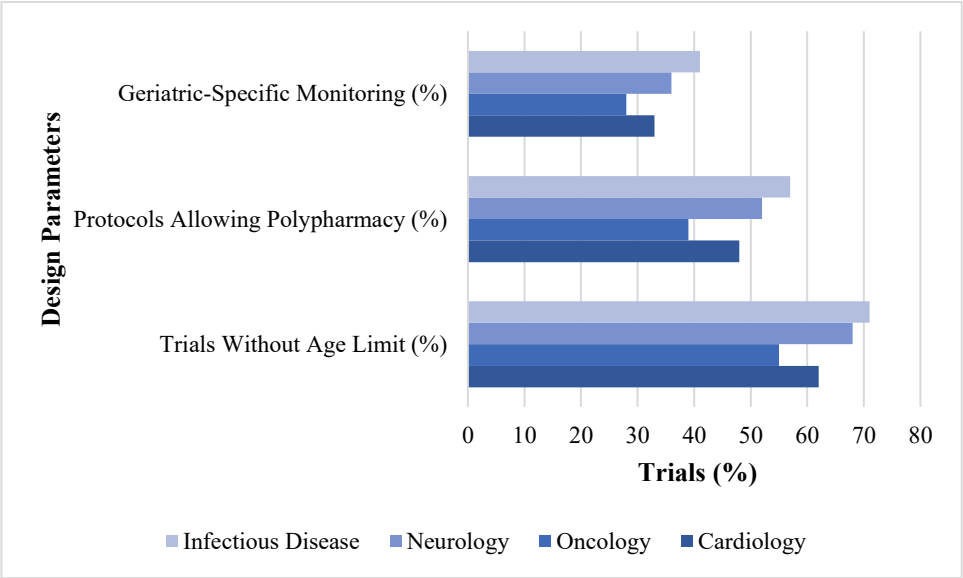

Figure 3: Design characteristics influencing inclusion of older adults

Figure 3 shows the design features that affect inclusion of older adults in clinical trials. It indicates that trials with no upper age limits, polypharmacy provisions, and geriatric surveillance have better inclusion of older adults. These features are important for the representation of older adults in therapeutic studies.

Socioeconomic Disparities

Social and economic disparities were manifested in access to participation in trials. The majority of trials were also concentrated in urban academic hospitals, which restricted the number of people in rural or low-income areas. Out of the studies that reported socioeconomic variables, a third of them reported disaggregated data. Cases where transportation or loss of wages were provided were more likely to be used by disadvantaged populations, but were not widespread. Geographic differences were strong, with the countries that had low and middle incomes providing fewer participants to the multinational studies, even though there were high disease burdens in the target conditions of these countries. Table 4 shows that low-income region trials with compensation and logistical assistance have greater enrollment from disadvantaged populations. This implies that financial and logistical assistance is key to enhancing participation from disadvantaged communities. The results indicate that the interventions can overcome barriers to trial enrollment in low-resource environments.

Table 4: Inclusion of participants from low-income groups and rural settings

Region	Trials Conducted	Low-Income Participants (%)	Compensation Provided (%)	Rural Representation (%)
High-Income	110	18	32	15
Middle-Income	70	24	21	12
Low-Income	40	31	14	10

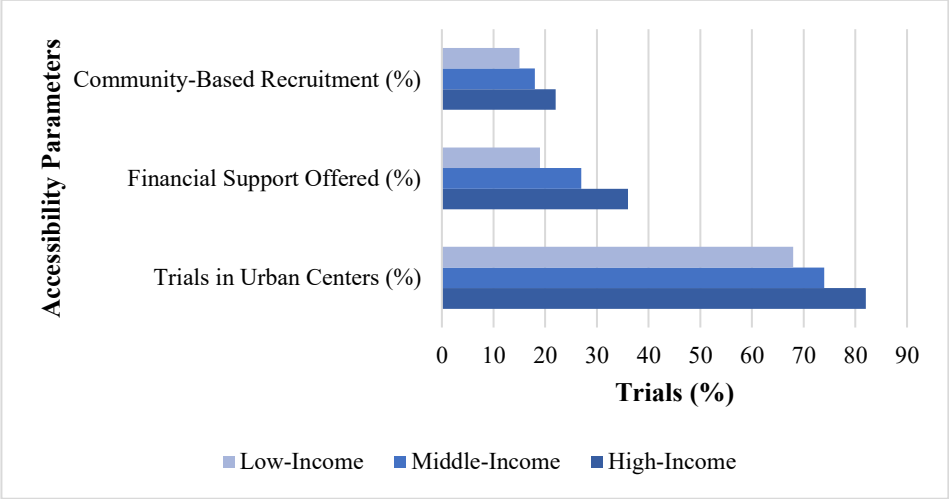

Figure 4: Socioeconomic accessibility and recruitment strategies by region

Figure 4 shows how digital technologies—such as tele-trials, e-consent solutions, and remote monitors—can be utilised increasingly to overcome geographic and socioeconomic barriers to trial participation.

Case Studies and Comparative Examples

Comparison of analyses demonstrated differences in models of funding. Infectious disease trials funded by the government in sub-Saharan Africa were found to have an almost equal gender representation and more rural subjects through the assistance of community-based recruitment and logistics. By contrast, oncology trials sponsored privately in North America had a disproportionately low number of female and older adults and also lacked a diverse socioeconomic background. These two opposing examples reveal how structural and financial determinants have an impact on inclusivity. They emphasise that despite the opportunities that can be made under enabling systems, inequalities are still present where corporate interests prevail over the greater interests of the general population. Table 5 shows the results of policy interventions across various regions, showing how formal diversity mandates and funding incentives have enhanced representation measures in recent years.

Table 5: Comparative Case Examples

Trial Type	Female Representation (%)	≥70 Years (%)	Low-Income Participation (%)
Govt-Funded (Africa)	50	31	28
Govt-Funded (Europe)	48	29	24
Private (North America)	42	18	15

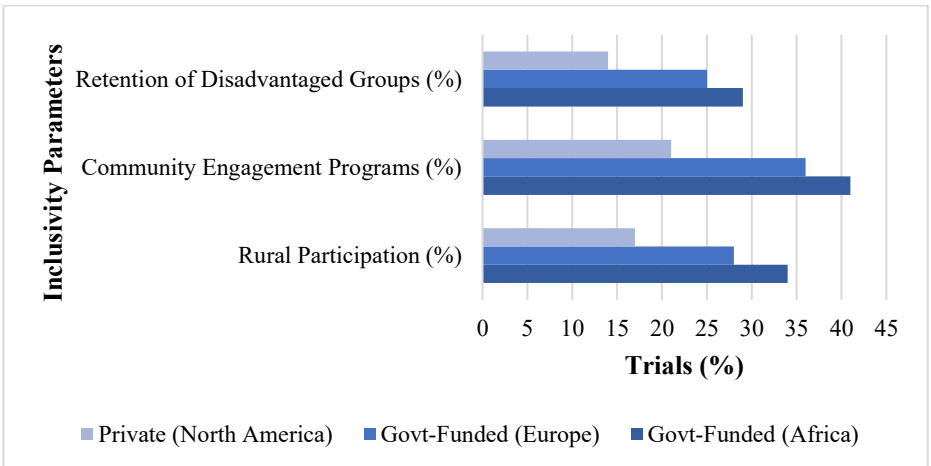

Figure 5: Comparison of inclusivity by funding model and geographic region

Figure 5 shows inclusivity based on the model of funding and region. The highest rural participation (34%), community engagement (41%), and retention (29%) were in Govt-funded trials in Africa. Europe came in second with 28, 36 and 25, and with the lowest were the personal North American trials of 17, 21 and 14.

Discussion

The data indicate that there are systematic inequities in demographic axes and settings. The coverage of reporting is also imbalanced: among trials, 67% of them reported sex distribution, 55% reported age stratification, and 32% reported socioeconomic indicators, which reduces secondary analysis and conceals bias (Table 1). The greatest gender disparity is in the field of cardiology, with 39 % of women enrolling into the field compared to a prevalence component of 52 % (gap = -13%), followed by oncology and neurology with -6% each and infectious disease with a -2 gap of parity (Table 2). The bias by age is still significant: participants aged 65 years and above represented 29% in oncology, 33% in cardiology, 35% in neurology and 38% in infectious disease and upper age limits were upheld on 40% of oncology studies and 28% of cardiology studies (Table 3). This trend is increased by the choice of trial design, where trials with no age restriction reached 71% in infectious disease, versus 55% in oncology, protocols permitting polypharmacy were between 39% and 57%, and geriatric monitoring between 28 to 41% (Figure 3). Geography and cost limit socioeconomic access: low-income representation was 18% in high-income areas and 31% in low-income areas, but the compensation rates were very low (32% in high-income areas; 14% in low-income areas) and participation in the rural areas was hardly over 15% (Table 4). Funding model and region: In government-funded trials in Africa, there were more women (50%), older adults (31%) and low-income subjects (28%) included compared to private trials in North America (42%, 18%, and 15% respectively) (Table 5). These trends imply that lack of transparency in reporting, eligibility restriction and lack of support mechanisms are major factors contributing to inequity. These disparities are, in turn, exacerbated by factors of intersectionality. For example, older women who are from minority groups or are disabled experience intersecting barriers at points of gender, age, race, and health status. These multiple overlapping disadvantages make them less visible in data and bias the relevance of results. Overcoming intersectionality forces trial designers to gather and analyse data broken down across multiple dimensions of demographics at the same time.

The detected gaps undermine external validity and signal detection of safety. Poor enrolment of women in cardiology (−13) may put women at risk of being excluded and adverse-event profiles that may not represent actual clinical populations. Older adults' restrictions and little geriatric surveillance decrease its applicability to patients who take up a huge portion of the burden of the disease and polypharmacy in real life. Low compensation rates and sparse socioeconomic reporting (32) undermine the engagement of disadvantaged groups, which contributes to treatment disparities and restricts the ethical concept of justice. Stronger regulatory criteria on disaggregated reporting, rationales of eligibility based on clinical, and not administrative restraints, and budgetary support of participants (transport, wage compensation and child/elder care) would deal with the essential obstacles. The funding-model opposition proposes that the public funding requirements are associated with inclusivity goals that can alter practice without making it less feasible.

General trends concur with familiar knowledge on the clinical trials ecosystem. Cardiology and cancer tend to exhibit higher gender and age discrepancies than infectious disease; the balance of enrollment tends to be more balanced, in the case of infectious disease, when there is a strong community involvement and decentralised process of delivering protocols. Disparity in inclusivity in funding models is also in line with reports that publicly funded trials are more frequently characterised by outreach, travel support, and flexible scheduling embedded in the trial [24]. Evidence of regulatory interventions underlines this strategy. The U.S. Food and Drug Administration's 2024 Diversity Action Plan has produced quantifiable increments of minority recruitment for oncology trials, and the European Medicines Agency now conditions trial approvals on meeting diversity targets. The UK National Institute for Health and Care Research also requires diversity plans as a precondition for

funding. These instances attest to how regulatory levers can effectively incentivise inclusivity. Meanwhile, there is a gradual change to improve: neurology demonstrates the increased accommodation to polypharmacy and monitoring compared to most previous testing, and infectious disease maintains the almost equal gender representation. In general, the alignment with the broader evidence base points to the fact that equity can be addressed in cases structural levers, such as eligibility design, location, and support of participants, are deliberately aligned [25].

These findings can be implemented into practice change by taking action. Disaggregation and transparency must become standard practice in reporting the trial, with sex, age, and socioeconomic information being routinely reported at registration and publication. Consensus of reporting standards with CONSORT-like checklists and development of publicly accessible dashboards to track compliance, e.g. with an aim of 90% coverage of sex, age fields and 60% of socioeconomic variables in two years, would promote accountability. Eligibility and monitoring changes are also required. No upper age limits of eligibility should be used except where upper age limits are pathophysiologically necessary, and default inclusion should be accompanied by prespecified geriatric safety plans. Standardised adjustments—such as detailed medication reconciliation, pre-existing dose-modification rules, and oversight by adjudication panels—would decrease exclusion for polypharmacy and comorbidity and enable the safe inclusion of older adults.

Inclusive recruitment and site strategy should also be taken into account. The scope of trials should extend beyond urban centres of learning, with minimum rural and diversity requirements based on the geography of the disease. The protocols must mandate community-based recruitment and participant navigators, particularly in those regions whose community engagement is less than 25% (as shown in Figure 4). Ring-fenced budgeting and support of participants are required, whereby funds are allocated to cover transportation, wage compensation, and caregiving, and compensation should be given at least in half of the trials in the regions within three years.

Digital health advances decrease geographic, economic, and logistical distances to trial enrollment. Tele-trial platforms and e-consent solutions allow remote enrollment and follow-up, especially among rural or underserved patients. Mobile health apps and wearable devices collect continuous data without the need for repeated site visits. AI-powered analytics can detect underrepresented patient groups during recruitment, allowing adaptive tactics.

Together, these technologies decentralise access to trials and enhance representation. Patient-centred design is also a central part of an inclusive study. Engaging patient advisory boards in trial planning ensures that procedures and eligibility criteria are experience-responsive. Culturally sensitive recruitment materials and flexible scheduling arrangements maximise participation, while ongoing feedback channels may optimise retention. These tactics not only increase the level of participation of minority groups but also allow for more accurate and higher-quality data. Equity can also be encouraged through the use of the funding lever and the oversight lever. Public and public-private funding will need to be tied together to demonstrate inclusivity plans and a track record of success in achieving diversity. Mid-trial equity audit should be performed, and outreach or site addition should be employed in the case where representative levels are not being attained. The analytic protocols also should be improved, and statistically prespecified subgroup analyses by sex, age groups of 70 years or greater vs. age groups of 80 years or greater, and socioeconomic strata, and report results irrespective of statistical significance to accumulate evidence. Finally, post-approval bridges must be built. Where large groups are systematically excluded from large trials, they must be supplemented with pragmatic trials or registry-based follow-up to identify poorly represented target populations, and translation of therapies to common practice is safer and fairer as a consequence. Although these gains make implementation less difficult, imposition raises ethical challenges. Quotas and required representation targets destroy voluntariness and autonomy, and collecting a lot of demographic information poses a threat to privacy violations in small or disadvantaged groups. The inclusion imperative must be balanced with people's preferences, data protection, and ethical recruitment approaches to avoid discrediting public trust. Despite the progress made in ensuring diversity in clinical trials, there remain shortcomings in study and regulatory practice. Emerging studies must be aimed at intersectionality, considering how gender, age, socioeconomic status, and other factors like

race, disability, and ethnicity intersect to create specific barriers to participation. All of these factors must be investigated collectively to address the multidimensional challenges faced by underrepresented groups. Furthermore, the greater utilisation of online recruitment sites, such as tele-trials and e-consent platforms, presents new opportunities for overcoming geographic and economic barriers to be overcome in participation in trials. More studies, however, must be carried out to evaluate the effectiveness of such resources and ensure that they do not have an adverse unintended effect of excluding people who have no access to electronic technology. Subsequent studies must engage with the intersectionality of socio-economic status, age, and gender. Low socio-economic older women, for example, are exposed to several overlapping disadvantages that unite to deny them trial access. These groups are excluded at a greater frequency because they experience several intersecting disadvantages, such as age, gender, race, and socio-economic status. Elimination of these intersectional barriers is crucial in maximising inclusivity and relevance to all patient groups. Whereas online recruitment tools, such as tele-trials and e-consent platforms, allow increased access, the possibility of increasing disparities exists. Those with limited or no access to consistent internet services or who are computer illiterate can be denied access to these hiring systems, thus further excluding underrepresented groups. Future studies must assess how digital platforms can become more accessible and inclusive so that they do not unintentionally leave behind exposed groups.

Conclusion

This study depicts the significant gaps that are present in women, adults, and socioeconomically disadvantaged populations' inclusion within clinical trials. These gaps undermine the scientific value of therapeutic studies and perpetuate health disparities among at-risk communities. Underrepresentation of these groups within clinical trials impedes the external validity of study results and jeopardises the ethical requirement of justice. Excluding some groups not only undermines the applicability of clinical trial findings but also widens systemic health disparities. Maintaining a priority on restricted diversity in clinical trials forecloses the potential to create knowledge that reflects the wider, more diverse population who will eventually receive these treatments. It is not merely a matter of ethics—it is a matter of scientific imperative. With designs for trials involving all groups, therapeutic progress threatens to fall behind the needs of those most affected by the diseases in question. Imposing open demographic reporting requirements, eliminating exclusionary discriminatory factors, and improving participant support systems are all necessary to meet these needs. Greater representativeness in clinical trials depends on open inclusion practices, such as eliminating needless age restrictions, granting adult populations universal access to polypharmacy, and encouraging equal participation for low-income and rural communities. Furthermore, the implementation of digital health solutions can facilitate the removal of logistical barriers to participation and increase participation from underserved populations.

It will be necessary for trial sponsors, regulators, and clinical trial developers to collaborate to create inclusive, equitable, and diverse trial requirements. Although regulatory guidelines such as the European Medicines Agency's policy and the FDA's Diversity Action Plan can be used as models to encourage inclusivity, more work needs to be done to ensure that these guidelines are applied consistently. By incorporating equity into clinical trial design, we ensure that all populations benefit equally from medical advancements while also enhancing the scientific rigour of therapeutic studies. These are crucial actions to combat the enduring disparities that still exist in healthcare systems worldwide and to enhance health outcomes. By working together to implement equitable procedures in trial design, recruitment, and reporting, this goal can be accomplished, and clinical trials will be able to accurately reflect the diverse populations that will eventually benefit from them.

Key Recommendations for Stakeholders

- Require transparent reporting of sex, age, socioeconomic status, race, and disability data.
- Remove non-clinical exclusion criteria, including upper age limits and exclusion for comorbidity.
- Offer logistical and financial incentives (transport, wage replacement, child care) to participants from disadvantaged groups.

- Employ online platforms and decentralised trial designs to enhance geographic coverage.
- Engage patient groups in protocol development, recruitment strategy, and dissemination plan.
- Undertake routine inclusivity audits and modify recruitment if representation aims are not achieved.

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