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Intersectionality in Quantitative Social Research: Methods, Limits, and Best Practices

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ABSTRACT

Intersectionality has become a critical framework in social science for understanding how multiple social identities and structures of power interact to shape experiences of inequality. While the concept originated in critical race theory and feminist scholarship, its integration into quantitative social research remains relatively recent and methodologically complex. This paper examines the conceptual foundations, methodological approaches, challenges, and best practices associated with applying intersectionality in quantitative analysis. It highlights the importance of theory-driven model specification, emphasizing that quantitative intersectional research must be grounded in clear conceptual frameworks that guide the selection of social categories, measurement strategies, and analytical methods. The paper reviews key quantitative techniques used to capture intersectional dynamics, including interaction terms, multilevel and cross-classified models, and multivariate or latent variable approaches. It also discusses critical methodological concerns such as measurement equivalence, sparse data problems, statistical power, and the interpretability of complex models. Furthermore, the study explores ethical considerations related to privacy, consent, and responsible interpretation of intersectional findings, particularly when such findings inform policy decisions. Empirical examples from health disparities, educational outcomes, and labor market trajectories demonstrate how intersectional approaches can reveal nuanced patterns of inequality that single-axis analyses often overlook. The paper concludes by outlining best practices for robust quantitative intersectionality research, including transparent reporting, preregistration of analytical strategies, sensitivity analyses, and cross-context validation. By integrating theoretical rigor with methodological transparency, quantitative intersectional research can more effectively illuminate the mechanisms that generate and sustain social inequalities and contribute to evidence-based policy and social justice initiatives.

Keywords: Intersectionality, Quantitative social research, Social inequality, multilevel modeling, Measurement equivalence

INTRODUCTION

Intersectionality in quantitative social research requires a theory-driven, transparent, and reproducible approach grounded in empirical evidence. Intersectionality has emerged as a key concept in equity studies across varied fields in social research [1]. It delineates how intersecting and mutually constitutive social positions such as gender, race, and class simultaneously shape the experiences of individuals and groups and produce systemic inequities [1]. Beginning in the late twentieth century, intersectionality has inspired theoretical innovations and methodological advancements in the social sciences, enabling researchers to investigate how distinct yet

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interconnected social characteristics collectively influence inequalities in diverse domains [2]. Application of the intersectionality framework to quantitative social research is nascent but growing rapidly and deserves careful attention [2]. The intersectionality literature emphasizes the vital role of theoretical grounding in shaping approaches to measurement, analytical methods, and interpretation [3]. Despite its recognition as an indispensable component of intersectionality research, theory-driven formulation of models remains rare in empirical work; many applications follow a “plug-and-play” modeling strategy that neglects this principle. Adopting a tighter focus on equity in the quantitative research process can deepen scholars’ insights into processes generating inequities and improve the fit between theory and technique [3].

Conceptual foundations of intersectionality

Proponents assert that intersectionality can expand social scientists’ understanding of the social world. Applying intersectional approaches simultaneously to multiple, socially constructed attributes enables quantitative methods to analyze the importance of each variable, the variances in significance, and the interactions between various categories [4]. From this standpoint, intersectionality switches the social constructionist debate over distinctiveness of categories into consideration of social positions or demographics reflecting not merely vantage points but agency and opportunity to engage in the social constructionist discourse and alter the course its analysis [2]. The choice of category is paramount in intersectional investigation. Although intersected properties may co-vary, little insight is gleaned from studying variables such as age and weight together. In fact, circumstances can arise wherein the inclusion of multiple constructs impairs the interpolation of single dimensions [3].

Origins in critical theory and sociology

The concept of intersectionality can be traced back to Black feminist thought. Critical race theorists established the need to study multiple social identities, showing that traditional race frameworks privileged White experiences [4]. In education, Gilborn and colleagues applied the term to emphasize the importance of simultaneously examining different social categories. Intersectionality recognizes that social stratification is based on multiple interlocking axes of identity, yet much quantitative research continues to treat social categories separately [5]. The term “intersectionality” was coined in 1989 by legal scholar Kimberlé Crenshaw to capture the cumulative disadvantages faced by women who experience both race and gender discrimination [5]. The need for intersectional approaches to the analysis of social difference has arisen from feminist critique of mainstream theories of social stratification, identity, and power, which these traditions assert to overlook or render invisible the multi-dimensional nature of difference [2]. Feminist theory has addressed diversity among women based on race, ethnicity, class, age, sexual orientation, and religion. Similarly, minority-group theory has demonstrated that blacks experience disadvantage not solely as a function of race but also differently based on such characteristics as class and gender [5]. Intersectionality emphasizes consideration of how identities and experiences intersect, co-evolve, and jointly shape stratification outcomes. Accompanying analytic complexity ensures that few mainstream empirical studies properly reflect this argument [6].

Core principles for quantitative application

The quantitative research literature addressing intersectionality requires an approach driven by a theory of the phenomenon under study, a firm grounding in evidence on its manifestations, and a commitment to reproducibility [7]. Because of its focus on cumulative disadvantage and the multi-layered nature of identity, social justice research lends itself readily to a quantitative operationalization of intersectionality [7]. Consequently, the choice of particular intersectional concepts, the corresponding empirical evidence, and their relationship to specific measures of social justice can all be articulated in clear, theory-driven terms. Moreover, intersectionality entails not only the analysis of how different categories of disadvantage combine but also a rigorous analysis of the trajectories of a single category [1]. The latter aspect can be investigated in empirical applications that focus on the intersection of a single category with multiple forms of disadvantage within both childhoods 2 and adulthood educational outcomes, using datasets that permit an examination of multiple categories [5]. Such datasets offer rich opportunities to ask questions concerning the interdependencies among categories that lie at the heart of the intersectional perspective [8]. Material deprivation, corporeal unattractiveness, and social stigma (between) disability offer similarly fertile ground for the formulation of theoretical questions and empirical investigation the modelling of poverty trajectories in the adult life course benefits from an awareness of how sex, sexual orientation, and ethnic minority status historically condition access to secure employment [9].

Quantitative Methods for Capturing Intersectionality

Feminist and critical race theories describe oppression as arising from the simultaneous operation of several dimensions of social identity, such as gender, race, and social class [1]. This conceptualization highlights the problematic nature of investigating the effects of social categories and their intersections with independent variables or parallel categorical stratifications [2]. Intersectionality theory emphasizes the primacy of social

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structure and the constitution of social identity as interplay of socially located, power-inflected identities that allow researchers to account for heterogeneity in the construction and impact of categorical identity without prejudice to the theoretical enterprise [1].

Interaction Terms and Moderation Analysis

With respect to measurement invariance, several additional sources extensively describe challenges associated with cross-group comparisons and suggest best practices [5]. Missing data and minimum observation counts raise severe practical concerns for disaggregated intersectional analysis, even at wider social group levels. Investigating intersectional disadvantage across three classes might scrutinize group combination b1 and level c1 simultaneously and features a maximum of pooled 27 observations when drawn, for example, from a secondary, publicly available survey administered within a limited region [6]. Though many users analytically prefer lumping one-off, rare cases into margin or constant categories under simple specification, researchers frequently neglect doing so despite numerous considerations around fewer, larger segments and transformations being paramount [7].

Multilevel and Cross-classified Models

Many social processes are structured by social and spatial interactions taking place across multiple levels, making multilevel modelling relevant for combining different types of data [1]. In educational research, for instance, some relevant policies are decided at school level, but schools are nested in districts where policies might be complementary, or lag behind. Education systems “matters” and “space” can both be examined at district level, while data on other schools and district are only available for some students, further suggesting a district level should also be included [2]. Similarly, contents taught are curriculum based, for which too much matching might lead to false assumption of comparable difficulty. Unlike content, pedagogy, even within curriculum, is still “matière”, thus an exploring such “matière” can be provided. Multimodel contents matter. In a study on teaching and administrative staff, satisfaction with administrative support is captured [3] (before, early, after); teaching “matière” change [4]. Timing of changes has much influence on the effect of per cent children of immigrant background on results, thus a more flexible approach implies at least 2 entries for “matière”. Being able to vary information across the pupils’ educational life cycle improves the representation of decision variables, especially when analysed on early tracked students or adults [4].

Multivariate and Latent Variable Approaches

Quantifying how individuals’ multiple and interwoven social classifications lead to variable experiences remains challenging. Nonetheless, multivariate and latent variable approaches can contribute [3]. They do so by first modelling distinct structural, spatial, or temporal classes or processes that form the theoretical basis of the multiple classified phenomenon of interest, and then allowing the models’ parameters to vary according to a person’s or subject’s intersectional classification [8]. The first step produces separate within-group models whose smoothing exists only within, not across groups and hence creates groups that are hopefully fundamentally different rather than merely reflecting heterogeneity about an invariant average. Any variation in the postulated group-specific model(s) captured by fitting a standard random-effects, random-coefficient, or latent-class specification is therefore interpreted as intersectionally driven [9]. With further modeling, even larger disparities may be substantiated. In addition, multi-group frameworks explicitly fit a model to each intersectional combination, and patterns of interest are then inspected across these models or their estimates [10]. Because of the compatibility between intersectionality and latent variable models, social network structures have also been examined by addressing selection and hence causal identification [4]. Latent-space random-effects frameworks and combined spatial, networked, and population models enable dynamic multilevel analyses of disease-preventive behaviors within social networks. Even where behavior differs more than individual social categories, such intersectional patterns may still reflect intersectionality; in education, comparison of schools rather than pupils across marginalized social classifications has revealed larger disparities within these structures [2].

Fairness, Equity, and Disparity Measurement

Intersectional approaches promise improved measurement and understanding of fairness, equity, and disparity, but progress remains limited [1]. Adopting intersectional frameworks can clarify how different social positions relate to social phenomena of interest, but the extent and success of such efforts varies significantly [2]. Although intersectionality scholars emphasize the need to move beyond the standard neglect of all-but-one affiliation, only a fraction of scholars using intersectional perspectives specify the relevant theory, research question, and associated expectations of empirical patterns [3].

Data Considerations and Operationalization

Critically examining data considerations in quantitative intersectionality research reveals multiple avenues for future application and development [1]. When illuminating the interplay between social categories, clear definitions of the specific categories being invoked, as well as the nature of their intersections, are essential. In

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many contexts, considerations of social position and difference may originate with broader indicators such as location, birth cohort, and social class [2]. Measurement equivalence is a central concern in quantitative social research, and the extent to which particular measures relate in the same manner across different social categories and the validity of these measures have significant implications for intersectional analysis [4]. Such concerns are particularly relevant when representing overlays linked to sensitive topics or in studies where additional measurement cannot be assured. Sample size considerations arise on multiple fronts. Sparse observations within selected groups constrain both analytical options and statistical power, limiting opportunities to specify or estimate intersection models, thereby enhancing the risk of biased inference from equivalent models estimated on aggregated data [6]. Data balance becomes increasingly complex and difficult to secure across multiple dimensions, especially when estimates are sought on very specific intervals of social position or difference. While the available choices may reflect theoretical priorities, consideration of the supply of data and the effective sample size remaining thereafter limits the realism of suitable intersectional applications [5].

Defining Social Categories and Intersections

Intersectionality in contemporary society denotes the simultaneous operation of multiple regimes of social discrimination [2]. Analogously, in quantitative research, the term describes political frameworks (e.g., class, ethnicity, gender) acting jointly, particularly when measuring their influence on social constructs like wages, health, and education [1]. Despite limited applications, it remains useful for quantitative scholars, bringing awareness to inadequate conceptualization of social categories and necessity of specifying how they interrelate. These points critically concern methodological ambiguity tied to the transparent and reproducible intersection. Hence, quantitative scholars applying the approach should stipulate and operationalize an intersectionally driven empirical question, identifying relevant forms of social categorization in the considered context while discussing additional categories that might directly or indirectly impact the phenomenon under study [6]. Researchers should bear in mind that intersectionality operates not only broadly across categories but also within specific social phenomena provided they cluster. For example, educational levels may contain urban or rural, private or public dispositions, hot or temperate climate, languages, and so forth [5]. Supplementary forms of class, gender, ethnic, and other categorization may therefore subsist depending even further on the nature of educational interest and the related contextual configuration. Specification of categories in each case and how they intersect stands central to further developing the analysis across time, space, culture, policy, and society [8]. Failure to accomplish adequate specification leads to lack of clarity in discerning similarities across investigations, hindering the collective accumulation of knowledge crucial for theory-building necessary for quantitative systems [9].

Measurement Equivalence and Validity across Groups

Research on group differences relies on the meaningful grouping of units into sociocultural categories or on identifying the similarities and differences among their group patterns of responses [6]. One form of the former is measurement invariance determining whether individuals share a common meaning of the measurement concept, whether the measurement indicates the same degree of the concept, and whether the assessment criterion is the same [2]. When developing a conceptual model including recourses (predictors, mediators, and moderators) and outcomes (dependent, instrumental, and latent), it is necessary to justify the applicability of separate recourses. In parallel, when assessing paralleled multilevel models, population heterogeneity becomes an essential consideration whether the same parameters are assumed (e.g., the same moderating effect) for all subpopulations [7]. Heterogeneous effects are represented in a different notation from interaction terms or joining interactions because these suggest a deterministic influence [9]. Measurement invariance does not guarantee homogeneous processes. In large-scale surveys, group differences often appear in the selection or grouping of recourses; prior manipulations may have received considerable attention. Nevertheless, if the group of respondents relates to the analysed problem, specifying recourses for a specific group (while leaving other groups to potentially only socio-structural attributes) can enhance interpretability [6].

Missing Data and Sample Size Considerations

Statistical power to detect intersectional effects typically remains high even when attention shifts to smaller demographic groups [3]. Reporting predictive margins or probabilities facilitates interpretation of intersectional effects. Nevertheless, interpretational challenges often arise during modeling beyond straightforward additive or deductive analyses [4]. Individual-level demographic attributes may correlate with unobserved factors related to the intersected phenomena. Data scarcity further restricts modeling options; complex structures such as cross-classified and multilevel random slopes may remain infeasible when separate analyses for the intersectional group or strata yield insufficient observations [1, 4].

Analytical Challenges and Limitations

Statistical power, sparse cells, and an insufficient number of observations are also key challenges in intersectional quantitative research [1]. When researchers would like to inspect the moderation of a social position by a second

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category or even explore the intersection of two characteristics, the associated models typically require comparisons of multiple groups. Such models, such as multiple-group structural equation modeling, become increasingly difficult to fit and interpret as the number of groups being analyzed rises [6]. Restricting analysis to only the intersection of two categories and creating entirely separate models for each intersection or conducting more complex analysis spanning extra categories becomes appealing in this context. When addressing groups represented by few individuals or when data are categorical, substantial attention must also be devoted to the adequacy and validity of the data at hand [2]. An especially compelling challenge at the level of application and reporting that arises from measuring multiple social axes relates to the interpretability of complex models and the risk of distilled conclusions being factually incorrect [12]. Intersectional methods are by nature multifaceted and often involve further optional sophistication through various techniques and estimation strategies [11]. They can easily elaborate into complex formulations in which the full constellation of interactions becomes difficult to parse. Researchers adopting such procedures or those considering their adoption should carefully reflect on and communicate the sum of the relationships their model specifies, how those relationships reflect the research question, and whether additional modelling simplicity could as effectively realize the scientific objective [10]. Mathematical-temporal and contextual invariance in increasingly intricate models remains common. Social processes operate through interactions not only with social categories but also with time, geographic location, and wider cultural, economic, and political contexts [9]. Teaching of categories as influential at a given point does not imply they embody the same influence at other moments, in alternative places, or within other frameworks 1. Explore inquiry into social categories over the environment at stake remains topical, the requirement does not preclude studying those categories where the expectation holds. Nonetheless, ever finer boxes risk distracting from existence of uncertainty regarding that constancy elsewhere [5].

Statistical Power and Sparse Cells

A minimal cell size of 50 respondents is deemed a common threshold for ensuring stability of estimates. However, it must be noted that optimal cell sizes depend on the research context and multiplicity of effects as well as other model specifications [1]. In study, the relationship between intersectional social strata and educational attainment is explored in terms of marginal probabilities consistently with a two-variable model already indicated, executed on the General Social Survey (GSS) US dataset from 1972 to 2021 [4]. A first interaction along four variables such as race, age, gender, and education is retained, producing a 32 interaction model, while a second model complements this network with a fifth but covariation-related one describing interaction between age and education, thus yielding all 64 first-order combinations in the same period [5]. All thereof therefore meet the above 50-respondent criterion, and the validity of such 50-respondent size nevertheless confirmed across a GSS sub-sample on top of other supporting robustness checks [8]. Yet, as considered hereafter, within on three between-gender strata of the highly significant final full-multilinear and multi-relational interaction model still half further respectively fall under and even below such lower limit, allegedly threatening accuracy of estimates in multi-identity-oriented situation stayed to describe and to express cross-contextual applicability [9]. Similar considerations prevail in case the ultimate multi-relation and coverage model alone be focused onto which on three nevertheless remain involved. After initial attempt to curb such dimensionality yet under-accessible a 12-way model of race supposes additional only within formations also drop, whilst age remains untractable or only count-ready effects amended [6]. A supplementary add-on affording discrimination at two levels, enabling to focus efforts on which additional nine, concedes beyond topical survey intricacies a fourth cluster instead of predetermined double [3]. Even with, final 9-by-250 still do not attain requisite 101 cumulated span; two out of eighteen either persist homogenic only/never-married else trifidly/intermediate-typed. Inspecialisation lastly revisiting wide coverage via reducible parameters discloses two uniform-16 counts, each involves early stage and consequently expansive aggregate exists [1].

Interpretability of Complex Models

Most complex statistical models, such as those capable of separately estimating the effects of multiple interactions and thus portraying social intersections in finer detail, are intrinsically more difficult to interpret than their simpler counterparts [3]. The probability structure or other model mechanisms become less transparent as additional assumptions are added, posing difficulties for readers who seek to understand both estimated quantities and identification strategies [4]. Even after accounting for high dimensionality, complex models may still not convey the desired interactivity. An active variable, rather than a dummy indicator, still permits non-linearity in the remaining mechanisms but cannot facilitate conditional relationships [4]. Non-permissive policies, such as fixed investments in particular social goods or narrowly defined funding criteria, which are equally present in all settings, may also violate independence but are much harder to formalize [5]. In quantifying the strength of intersectionality involving multiple features, statistical techniques that separate spatial from temporal variation treat social categories as purely insensitive to geographical influences. These tools essentially carry out yet

another long-standing crux of the social sciences: disentangling geographical from chronological effects [6]. Such concerns also arise from the comparative-historical methodologies pioneered by Max Weber. These concerns play out different roles when the focus remains within individual-only, aggregate-only, or sector-only frames, which receive greater methodological attention overall [7]. Pooled analyses of repeated cross-sections or panel datasets (IPUMS, 2023) represent the most advanced current quantitative articulation of intersectionality but remain highly manipulable [3]. Various econometric methods are available to disentangle these influences and whether, when and how they vary across features retains independent significance [8].

Risk of Essentialism and Reification

In the existing intersectional approaches, the intersectionality approach risks drifting toward an essentialist stance. Intersectional approaches increasingly consider intersectionality as a tool for revealing multiple social positions [6]. This trend blurs the boundaries between producing intersectional analyses and pursuing an intersectional agenda, weakening both theoretically and methodologically [9]. Quantitative research continues to examine how multiple social positions affect life chances across education, employment, and health [2]. Substantive discipline-focused intersectionality research is beginning to emerge, although the majority of production takes the form of single methodological avenues [1]. The emerging research extends theory and scrutiny identifying major opportunities to develop theoretical approaches and specifying discrimination and policies to address it [2].

Temporal and Contextual Invariance

The need for contextual invariance imposes two important conditions on intersectional analyses. First, analyses require groups defined by the same variables and levels of measurement across the model-building process. Different arrangements of variables would produce different models so that, potentially, very different results could be observed [9]. Second, invariance in the relations among numeric variables across time or space is required to assure the contemporaneous applicability of the results. Analytical models typically embody a network of interrelations among variables. Data and variables must meet specific temporal or contextual standards to meet the broader condition of consistency [8]. Analysis of longitudinal data involves tradeoffs among measurement and sampling choices. Researchers encounter temporal invariance in longitudinal data. Data on the same variables collected at different times are placed into distinct data sets to form and test standards that would depict the relations embedded in the larger model [7]. The pattern of relations among the variables across the different times serves as the indicator of variation diversification or continuity. A poor-quality representation at any place in this wider mapping diminishes the overall pragmatism, so that an adequate description is needed for sustained generality [4]. Technologies have been developed to probe the condition of invariance and to visualize the consequences of failures to meet this standard [2].

Best Practices for Robust Application

Intersectionality in quantitative social research requires a theory-driven, transparent, and reproducible approach grounded in empirical evidence [9]. To achieve robust application of intersectionality in quantitative social science, researchers are encouraged to adhere to best practices regarding model specification, reporting, validation, and governance. Intersectionality remains a conceptual and methodological framework, with scientific interpretations of intersectional theory governing its implementation in a research context [1]. Theory-driven research questions, hypotheses, and models should explicitly relate to an identified conceptualization of intersectionality [4]. The selection of quantitative data and methods should be guided by best-practice approaches to the form and level of the causal questions posed [5]. Preregistration of research design, analytic strategy, and non-ambiguous specification of variable measurement should be encouraged [7]. The exposition of a model is further enhanced by clear, non-promotional reporting, including the uploading of analytic code, the execution of sensitivity analysis or robustness checks on critical aspects of the approach, and the exploration of convergent patterns of association with other data collected in other periods or settings [8].

Theory-driven Model Specification

Theory should guide specification of intersectional models. Because quantitative approaches must rely on aggregated measures of exposure, an understanding of the underlying social processes that produce the data is crucial for identifying appropriate intersections of categories or groups [2]. Even if literature-based theory cannot suggest a unique intersectional specification, it can help researchers articulate the processes of interest and decide whether to model those processes using intersectionality or alternative approaches [2]. Choosing social categories that generate focus on the theorized processes can also clarify the decision [4]. For instance, intersectional theorists and other scholars seeking to foster a more generalized understanding of inequalities may use age together with an array of categories representing social stratification to study resource-rich youth, modeling intersections that spotlight the underlying distribution of opportunities [6]. Such a rationale sits at the center of intersectional investigation and justifies the selection or prioritization of categories employed in multifaceted

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cumulative disadvantages even in the absence of established literature concerning particular joint processes [7]. Transparent model specification and operations that permit others to reproduce and scrutinize their decisions ultimately reside within a productivity-enhancing framework for advancing the science of intersectionality. Grounding the specification in theory provides a foundational basis for the accompanying description and justifies those decisions in the form of science itself, demonstrating that intersectionality remains a productive avenue for further theoretical exploration and expansion [9].

Transparent Reporting and Preregistration

Quantitative modeling expressly captures multi-dimensional features of the social phenomena of interest [2]. It follows that practitioners should evaluate a model's theoretical rationale, estimated parameters, and goodness-of-fit; perform sensitivity analysis on all key assumption; and report the results and checks extensively [1].

Sensitivity Analyses and Robustness Checks

The acknowledged limitations of intersectional quantification methods make knowing the extent to which empirical results depend on certain model assumptions especially important [9]. Sensitivity analyses and robustness checks examine how conclusions change when model specifications or other methodological choices vary [5]. Because intersectional quantification consists of a set of measures for the various ways intersections and social categorization can be treated, it is natural to apply such checks to these assessing how findings vary depending on whether, for example, sex and region are treated as independent, or whether disparities are measured using additive, interacting or other approaches [1]. An appropriate focus may also be on social identity variables tied directly to social power and inequality; applying knowing in parallel a broader set of specifications or allowances to identity variables that are not thematically or substantively connected to power can further clarify dependence of results on theoretical assumptions [7].

Replication and Cross-context Validation

Although intersectionality analysis is often more complex than a single-position analysis, this increased complexity does not imply that empirical findings can only be isolated or that intersections need to be addressed in one study [7]. Scholars frequently conduct multiple studies relying on temporally distinct data to examine the relevance of a theory across diverse contexts. Cross-contextual comparison represents another widely accepted robustness strategy [8]. Cross-contextual "replication" involves the examination of either identical or substantially equivalent patterns of association grounded in a shared theory or conceptualization, while "cross-context validation" entails documenting that an emerging theory is relevant in a distinct setting [1].

Case Studies and Empirical Examples

National and cross-national health research has long acknowledged a relationship between socioeconomic status (SES), social perceptions of low SES, and health [1]. Despite more granular approaches, significant knowledge gaps remain. Work exists, particularly in North America, on health disadvantages associated with low socioeconomic status (SES) but with no attention to class perceptions, which are a driving force of health inequalities [2]. Research also applies multi-dimensional approaches to examine economic capital, social capital, and cultural capital but still does not accommodate class perceptions [7]. A substantial literature examines poverty, income inequality, and health but ignores that disadvantaged populations and those perceived to be economically disadvantaged may not be the same. In both Sweden and the United States, for example, racial/ethnic minorities are over-exposed to income inequality but not considered low-SES groups by most citizens [8]. Even wealthy Black Americans encounter societal perceptions of low economic status tied to race and place of residence. Further, on the write of large literature on inequalities in educational outcomes in relation to a number of characteristics such as gender and ethnicity, the intersection between such characteristics has not been explored [9]. Especially in countries with high levels of human capital, education is a critical determinant of economic opportunity, but evidence of standardized test score inequalities widely viewed as a precursor to disparities in educational attainment across intersectional strata is lacking, especially in the European educational context [11]. Finally, in the labor economics field, powerful studies demonstrate significant and persistent wage penalties associated with motherhood compared with childless women and far lower earnings for Black than White women, yet the phenomenon has not been studied in relation to the intersection of race and motherhood [3]. Most quantitative educational and labor-market research takes the demographic characteristics of gender, race, and parental background into account separately, but intractable intersections of social characteristics still warrant investigation. Understanding how subgroups defined by the intersection of these characteristics experience educational and labor-market processes differently remains an important challenge [4].

Health Disparities across Multiple Social Positions

Social positions such as race, gender, sexual orientation, and socioeconomic status influence how health disparities manifest in different population groups [12]. Disparities are particularly pronounced among individuals with multiple marginalized identities such as Black lesbian women who face compounding inequities for certain health

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outcomes [7]. The intersectionality paradigm enhances the understanding of these complex social processes and guides the identification of health disparities across demographic strata [9]. Quantitative research can therefore benefit from carefully situating empirical analyses within an intersectional framework to obtain clearer insights into realities experienced by different populations and formulate empirical questions conducive to intervention [10].

Educational Outcomes and Intersectional Strata

Contact with educational institutions affects future study, vocation, and position within a society. Problems of inequality in education take advantage of discrimination mechanisms related to sex, race, and socio-professional background [5]. Patterns of discrimination operate differently across sex, race, ethnicity, and socio-professional background. In London, statistically significant inequalities arise in predicted levels of student achievement related to gender, ethnicity, poverty, special educational needs, and the combination of such characteristics [8]. The growing incorporation of formal multilevel methods in social research that properly address the presence of hierarchies can help identify and analyse intersectional inequalities [9]. The mathematical notation of general multilevel structures allows different equality definitions to be expressed. Where quantitative and qualitative approaches meet, it is important to think of quantification as an articulation of how intersectional effects interact with probabilities of movement between academic achievement levels within a cohort [8].

Labor Market Trajectories and Demographic Intersections

Intersectional research on employment trajectories for Black American youths shows that youth of both genders experience multiple hazards while seeking stable employment, but young men face disadvantages at every age compared with women and compare unfavourably to White youth [3]. Using time-varying covariates and event history analysis on a sample from the National Longitudinal Survey of Youth 1979, modelling the probability of exits from employment on 12,814 spells of employment among 5,196 respondents, the following patterns emerge. Both White and Black males leave jobs sooner than their female counterparts, with a notable increase among Black respondents at another threshold [5]. Effects also diverge between the two ethnic groups: Black respondents leaving public education enjoy a higher chance of an employment position than their White counterparts, but the likelihood to exit from employment is greater for Whites [6]. Further modelling a period and a cohort effect demonstrates that both cohorts exiting the “youths” period supplied less lucrative employment than those graduating from public education. The investigation is based on longitudinal retrospective employment data of five annual life-history interviews on a sub-sample of 5,196 young people from the original NLSY79 cohort [7].

Ethical Considerations and Governance

Quantitative social research addressing intersectionality must adhere to ethical standards appropriate to individual situations. Common ethical principles in research with human subjects include respect for persons, beneficence, and justice [9]. These principles translate into operations such as obtaining informed consent, protecting participant privacy, and ensuring the responsible use of data to produce fair and unbiased results, especially when the results might affect public policy [7]. Sensitive data should only be analyzed with the permission of data protection authorities. Responsible interpretation of findings particularly when disseminating results to lay audiences entails accurately characterizing the research, avoiding making unsubstantiated claims or recommendations, and spelling out the associated uncertainties [8]. Governance mechanisms exist to help ensure that ethical principles are upheld and that ethical research is conducted. Governance procedures in academia are typically grounded in regulatory and guidance documents, such as the Declaration of Helsinki, the United Nations Universal Declaration of Human Rights, or national governmental regulations, such as the U.S. Department of Health and Human Services Regulations 45 CFR 46, Protection of Human Subjects, and the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans [5]. Research that involves data sets containing sensitive personal information may fall under the purview of data protection regimes. The European General Data Protection Regulation, for example, requires that data governance measures are put in place before sensitive personal data are analyzed [2].

Privacy, Consent, and Data Governance

Intersectionality requires the consideration of groups defined by multiple social categories. Thus, privacy, consent, and ethical handling of the intersectional data become crucial considerations [5]. Two overlapping issues arise. First, intersectional studies often call for atypical data specifications that need special attention, especially when they fall outside traditional social categories, such as age and open text. Second, a larger ethical imperative call for careful data handling, particularly by citizen-scientists who wish to engage the data collected by other researchers [6]. Also, interaction of privacy, consent, and data governance deserves to be examined within intersectional studies. Privacy is a normative property constraining the acquisition, storage, dissemination, and usage of data. Consent is a formal action permitting data to change these normative values. Data governance comprises appropriate regulations on data [7]. In a rapidly changing environment, improvised definitions can fail to capture

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the contemporary essence of the terms [10]. The notion of privacy is defined as “the ability of an individual or group to control access to personal information.” Data privacy concerns the way personal information is collected, stored, shared, and used [8]. Such a notion tends to be contextual. Certain information can stay private in one context while its sharing can be deemed appropriate in another. Information is generally encrypted or anonymised when data privacy is actively safeguarded. The contemporary transformation of acquiring personal information now puts “privacy” in an adequate definition. Big data treats huge data as one set from which a pattern can be extracted [9]. There is thus an urge to redefine privacy and consent within citizen-science and big-data contexts. A model of 28 data governance elements examines the enabling nature of new data governance adapted to citizen-science and big-data solutions, with constructs such as public-good, add-value, enabling, governance system, citizen, researcher, health, and society, all weaving well within the implied organisation [10]. Another term among privacy, consent, and data governance studies is “consent.” Very few researchers claim that consent can be explicit under the big-data setting. Such acknowledgement has emerged not only in the realm of social science, but also within the legal domain [10]. Regulatory framework on personal data thus requires a genuine revision. Consent is not a single-shot action. Rather, it is a continuous process [10]. Such pattern fits an “interface” notion. The concept of structure indicates that a solid ground or scheme needs to exist “within consent, acceptance, control, and throughout with rich listening” constitute the inner consideration of such an interface [11]. In the case of health data without intervention, the individuals concerned are still given the right to be informed about data usage. The whole process has ranged to strict governance. Public attitude has moved to emotional-oriented consideration seeking to direct complete security or nominal assurance of data invisibility [12].

Responsible Interpretation and Policy Implications

The interpretation of statistical models addresses foundational concepts of intersectionality, which challenge mainstream notions of causality associated with social position and merit [2]. Treating social positions as deterministic predictor variables can reinforce dominant ideologies that obscure discrimination and preserve existing power structures [3]. Statistical effects representing systematic variation attributable to social positions reflect differences in exposure or vulnerability and are best interpreted as demonstration of the generalizability of causal relationships across social groups. Causality refers to the probability of an outcome as opposed to a mere statistical association and must be evaluated given the specific context, including the applied model and the interpretation of sociodemographic groupings [2]. Policy recommendations based on the intersectional analysis of survey data should therefore be tempered, as causal claims cannot be substantiated [2]. Appropriate measures rely on a broad interpretation of socio-demographic factors as indicators of distributions of opportunities and resources rather than intrinsic characteristics [3]. Attention to intersectional theory indicates the relevance of broader groupings such as socio-economic status and age, continuums along which advantages and disadvantages are differently apportioned according to different stratifications [1]. Notion of sensitivity to intersectional needs, describing the extent to which the effectiveness of a given intervention is contingent upon specification along several socio-demographic classifications, conveys a more precise understanding than an interchangeable concept of diversity or multiplicity of social status characteristics [9]. Analysis employing progressively more complex multi-level datasets that permit consideration of sub-groups along multiple stratifications conventionally accorded prominent status in macro-quantitative applications nevertheless frequently yields ambiguous conclusions as to how far group-specific effects diverge [10]. Environmental dependence on socio-demographic stratifications of various types, though uniformly present, is exhibited by education both in general and in respect of policy application provoking interest in large-scale datasets affording observation across different societies and comparative cross-polity investigation. The concept of intersectionality furthermore relates directly to large-scale analyses featuring social categories over which it is impossible to accept that similar causal dynamics are at play [11]. Data-generation processes proactively designed to introduce and contextualise social categorisation structures conducive to intersectional inquiry offer a promising avenue for investigation into differential policy and treatment effects across stratifications more encompassing than those denoted by readily observable socio-demographic characteristics [12].

CONCLUSION

Intersectionality provides a powerful analytical framework for understanding how multiple dimensions of social identity and structural inequality interact to shape individual and group outcomes. As this paper demonstrates, integrating intersectionality into quantitative social research requires careful attention to theoretical grounding, methodological rigor, and ethical responsibility. Although quantitative approaches offer valuable tools for examining complex patterns of inequality, their effectiveness depends on the extent to which researchers clearly specify the social categories of interest, justify their intersections, and align analytical techniques with the theoretical processes under investigation. The review of methodological strategies shows that interaction models, multilevel and cross-classified frameworks, and multivariate or latent variable approaches can effectively capture

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the multidimensional nature of intersectional inequalities. However, these approaches also present significant analytical challenges, including sparse data across intersectional groups, limited statistical power, measurement invariance concerns, and the interpretability of increasingly complex statistical models. Without careful design and transparent reporting, such challenges may lead to biased estimates or oversimplified interpretations of intersectional dynamics. Addressing these limitations requires adherence to best practices in quantitative research. Theory-driven model specification, clear operationalization of social categories, and transparent documentation of analytical decisions are essential to ensure reproducibility and scientific validity. Sensitivity analyses, robustness checks, and cross-context validation further strengthen empirical findings by demonstrating whether results remain consistent across alternative specifications or different datasets. In addition, ethical considerations, including privacy protection, informed consent, and responsible interpretation must guide the use of intersectional data, particularly when findings may influence public policy or social interventions. Ultimately, the continued development of quantitative intersectionality research depends on balancing methodological sophistication with theoretical clarity and practical feasibility. By adopting rigorous and transparent approaches, researchers can move beyond single-axis analyses and generate more comprehensive insights into the mechanisms through which social structures produce and maintain inequality. Such advances will enhance the capacity of social science to inform equitable policies and interventions that address the complex realities of diverse populations.

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