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Cost-benefit Analysis of Early Speech-Language Intervention in Children with Autism Spectrum Disorder: A Public vs. Private Sector Perspective in Pakistan

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Abstract

Background: This study examines the cost-benefit analysis of early speech-language intervention for children with autism spectrum disorder (ASD) across public and private healthcare sectors in Pakistan, addressing the gap in comparative cost-effectiveness research within developing country contexts.

Methods: A cross-sectional comparative design included 256 participants (128 per sector) from Karachi, Pakistan, targeting parents of children with ASD aged 2-6 years receiving speech-language therapy. Data collection utilized demographic questionnaires, validated clinical assessments (CARS-2, PLS-5, VABS-3), comprehensive cost instruments measuring direct and indirect expenses, and quality of life measures. Economic evaluations employed cost-effectiveness and cost-benefit analysis frameworks.

Results: Private sector families demonstrated substantially higher socioeconomic status (71.9% earning >PKR 75,000 monthly versus 10.2% public sector). Children in private settings achieved superior outcomes: 12.8-point higher language scores and 11.3-point socialization improvements. Despite higher annual costs (PKR 198,450 versus PKR 89,340), private sector services showed better cost-effectiveness with superior benefit-cost ratios (2.12 versus 1.84), higher quality-adjusted life years (0.78 versus 0.62 QALYs), and shorter payback periods (2.8 versus 3.2 years).

Conclusion: This provides Pakistan's first comprehensive cost-benefit analysis of early speech-language intervention for ASD children comparing healthcare sectors, offering empirical evidence demonstrating substantial investment returns while revealing critical socioeconomic access disparities.

Keywords: Autism Spectrum Disorder, Cost-Benefit Analysis, Early Intervention, Healthcare, Speech-Language Therapy.

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1. INTRODUCTION

Autism spectrum disorder (ASD) is a complicated neurodevelopmental disorder that influences the way individuals socialize, communicate, and process the environment. Individuals with ASD generally have enduring difficulties with social interaction and communication, as well as limited, repetitive behavioral patterns, and limited interests (American Psychiatric Association, 2013; World Health Organization, 2024). What is so difficult about ASD is its variability—no two cases are identical. In addition to the primary symptoms, individuals often develop changed sensory sensitivity, hyperactivity, attention problems, behavior issues, and disturbances in emotional regulation, sleep patterns, and mood. These manifestations vary so much that ASD is a lifelong disorder with deep implications not only for the individuals themselves but for their whole families (Hodges et al., 2020; Solmi et al., 2022).

Since the 1990s, we've witnessed a dramatic rise in ASD diagnoses worldwide. Current data suggests that somewhere between 1 in 100 to 1 in 127 people globally receive an ASD diagnosis (Zeidan et al., 2022; World Health Organization, 2024; Issac et al., 2025). While some of this increase reflects better diagnostic tools and greater awareness among healthcare providers and parents, it also underscores an urgent reality: we need effective, accessible intervention strategies now more than ever (Maenner, 2023). Most children with ASD begin showing symptoms somewhere between 12 and 18 months of age, though sensory and motor differences often appear even earlier—sometimes during the first year of life (Maksimović et al., 2023). Parents might notice that their child doesn't respond to their name, avoids eye contact, shows little interest in shared activities, uses few gestures to communicate, or engages in repetitive behaviors. Language development represents one of the most variable features of ASD. Some high-functioning individuals develop normal or even exceptional verbal abilities with grammatically correct sentences, while others at the lower end of the spectrum may have severely limited speech, use only simple phrases, or remain entirely nonverbal. But here's what remains consistent across the board: pragmatic language use—knowing how and when to use language appropriately in social situations—stays compromised for virtually all children with ASD (Fuller & Kaiser, 2020; Pereira et al., 2025). This deficit significantly impacts their ability to navigate daily social interactions and build relationships.

Over the past few decades, speech-language intervention has become a cornerstone approach for helping children with ASD, particularly during early childhood when the brain shows remarkable plasticity (Dawson, 2008; Chen et al., 2024). Research consistently shows that starting intensive interventions early—ideally between ages 1 and 3—yields the best results in terms of language development, social skills, and reducing core autism symptoms (Fuller & Kaiser, 2020; Avula et al., 2025). Take the Early Start Denver Model, for example. Studies have demonstrated significant improvements in both language and social skills among toddlers aged 18-30 months who received this intervention (Rogers et al., 2012; van den Berk-Smeekens et al., 2020). What makes these programs even more effective? Active parent involvement. When parents participate in the therapeutic process, children get more opportunities to practice their new skills during everyday routines and natural learning moments (Maksimović et al., 2023; Roberts & Kaiser, 2011).

When it comes to healthcare decision-making, cost-benefit analysis has become increasingly valuable, especially for interventions targeting developmental disabilities like ASD (Romeo et al., 2006; Buescher et al., 2014). These analyses help everyone involved—policymakers, healthcare administrators, and families—understand both the immediate financial investment required and the long-term economic benefits that result from improved

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outcomes. For ASD interventions specifically, we need to account for obvious direct costs like therapy sessions, diagnostic assessments, and materials. But we also can't ignore indirect costs: family time commitments, lost work income, and the opportunity costs of caregiving (Tinelli et al., 2023; Rodgers et al., 2020). On the benefits side, we're looking at clinical improvements in communication and behavior, better educational outcomes, enhanced quality of life, and reduced long-term care needs. The economic impact ripples outward too, affecting society through increased productivity potential and decreased healthcare utilization throughout individuals' lifespans (Leigh & Du, 2015; Cakir et al., 2020).

Despite what we know about the effectiveness of early speech-language intervention for children with ASD, there's a significant gap in our understanding of how these services actually work across different healthcare delivery systems—particularly in developing countries like Pakistan (Imran et al., 2011; Shrestha et al., 2024). The health system in Pakistan operates on two parallel paths: public and private. The two sectors exhibit different models for the provision of services, the utilization of resources, and accessibility. The public sector typically provides services that are financially supported, but may not have the availability of educated specialists, sufficient equipment, or program intensity. In contrast, private sector facilities may provide more thorough and individualized therapeutic services, but their high rate of charge is not affordable for many families (Bashir & Khanum, 2024; Syed et al., 2007). This difference in service affordability highlights the importance of assessing the cost-effectiveness of early speech-language intervention in both sectors of healthcare. This type of evidence is important to inform policy decisions, best use of resources, and to facilitate fair service provision for all children diagnosed with ASD in Pakistan and their families, regardless of their socioeconomic status (Karpur et al., 2019; Bishop-Fitzpatrick & Kind, 2017).

2. METHODOLOGY

2.1 Research Design

This cross-sectional study examined the cost-effectiveness of early speech-language interventions for children diagnosed with ASD within both public and private healthcare systems operating in Karachi, Pakistan. The study population consisted of parents or primary caregiver of a child 2-6 years of age diagnosed with ASD who was receiving speech-language therapy in a publicly funded healthcare system or a privately run healthcare system.

2.2 Population and Sampling

The sample size was determined using a two-sample means comparison formula with the following parameters: a significance level (α) of 0.05, a statistical power of 80%, a medium effect size (d = 0.5), and an anticipated attrition rate of 15%. This yielded a required sample of 128 participants per group, totaling 256 participants equally divided between public (n = 128) and private (n = 128) healthcare sectors.

2.3 Eligibility Criteria

Parents of children aged 2-6 years with confirmed ASD diagnosis according to DSM-5 criteria (American Psychiatric Association, 2013) were included. The children needed to have received speech-language intervention for at least 6 months, maintained regular attendance at therapy sessions (minimum 80% attendance rate), and their parents

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had to be willing to participate and provide informed consent. We also needed therapy records and assessment data available. However, children with co-occurring severe intellectual disabilities or genetic syndromes, families who had switched between public and private sectors during the intervention period, those with incomplete therapy records or assessment data, and parents who couldn't provide reliable cost information were excluded.

2.4 Data Collection Strategies

Multiple strategies were employed for data collection, incorporating both quantitative and qualitative approaches. Recruitment began by identifying eligible facilities through healthcare directories and professional networks. Connections were then established with facility administrators and clinicians to systematically review patient records, identify potential participants, and apply computer-generated random numbers for selection within each stratum. Initial contact with families was made through healthcare providers, followed by informed consent procedures and participant enrollment.

Data collection was conducted in three phases. Phase 1 (Months 1–3) involved baseline activities, including facility recruitment, ethics approvals, staff training on data collection protocols, and pilot testing of instruments with 20 participants. Phase 2 (Months 4–8) encompassed the main data collection phase, involving systematic participant recruitment, administration of clinical assessments by trained evaluators, parent/caregiver interviews for cost and quality-of-life data, and collection of therapy records and documentation. Phase 3 (Months 9–10) focused on data verification and cleaning, including double data entry, verification, follow-up on missing data, and comprehensive data quality checks.

2.5 Outcome Measures

A comprehensive assessment approach utilized several validated measurement tools:

A Demographic and Clinical Questionnaire documented participant characteristics including child-specific variables (age, sex, autism severity level, and co-occurring conditions), household demographics (economic status, parental educational attainment, and employment), and therapeutic history (intervention duration, session frequency, and service modalities accessed).

Economic burden was quantified through a “Cost Assessment Instrument (CAI)” that documented direct medical expenditures including therapy session charges, diagnostic evaluation fees, travel expenses, and therapeutic materials. Additionally, indirect financial impacts were captured, encompassing parental employment disruptions, caregiving-related opportunity costs, and supplementary childcare expenses. Out-of-pocket expenditures were itemized, including insurance co-payments and deductibles, supplementary therapeutic services, and purchases of adaptive devices.

Clinical outcomes were evaluated using established standardized measures. Autism symptom severity was assessed via the “Childhood Autism Rating Scale-2” (CARS-2) (Schopler et al., 1986; Samadi et al., 2025). The “Preschool Language Scale-5” (PLS-5) evaluated linguistic development. Adaptive functioning and social

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communication capabilities were measured through the "Vineland Adaptive Behavior Scales-3 (VABS-3)" and "Social Communication Questionnaire (SCQ), respectively.

Quality of life domains were examined using multiple instruments: the Pediatric Quality of Life Inventory (PedsQL) assessed child well-being, the Family Quality of Life Scale (FQOL) evaluated household functioning and satisfaction (Cheng et al., 2022; Zeng et al., 2020), and the Parental Stress Index-4 (PSI-4) measured caregiver stress burden (van der Lubbe et al., 2025; Rusu et al., 2025).

2.6 Data Analysis

The economic evaluation framework contains two evaluative methods; i.e. "Cost-effectiveness analysis (CEA)" provided the primary measure of economic effect, cost per unit increase in child language assessment scores (PLS-5), followed by the additional measures of cost per unit increase in adaptive functioning, and quality of life benefit. Whereas, "Cost-benefit analysis (CBA)" converted health outcomes into a more tractable measure, quality-adjusted life years, compared total costs with total benefits, and calculated benefit-cost ratios for each healthcare domain (Romeo et al., 2006; Rodgers et al., 2020).

Sensitivity analyses included three components to evaluate analyses: a univariate sensitivity analysis examining a select number of important cost parameters, a probabilistic sensitivity analysis using Monte Carlo simulation techniques, as well as scenario analyses to evaluate changes in intervention intensity levels.The statistical analysis comprised descriptive analysis—means, standard deviations, and ranges for continuous variables, frequencies and percentages for categorical variables, and graphical presentations of cost and outcome distributions. Comparative analysis used independent t-tests for continuous variables, chi-square tests for categorical variables, and Mann-Whitney U tests for non-parametric data. For economic analysis, incremental cost-effectiveness ratios (ICERs), bootstrap confidence intervals for cost-effectiveness estimates, and cost-effectiveness acceptability curves were calculated. Multivariate analysis employed multiple regression analysis controlling for confounding variables, generalized linear models for cost data, and propensity score matching to address selection bias. Statistical analysis was conducted using STATA version 17.0, economic modeling using TreeAge Pro 2023, and data management using REDCap electronic database.

2.7 Ethical Considerations

Ethical approval was obtained from the Institutional Review Board of participating institutions, ethics committee approval from Pakistan Medical Research Council, and facility-specific approvals where required. Participant protection measures included informed consent from parents/caregivers, assent from children aged 6 years when appropriate, confidentiality protection through coded identifiers, right to withdraw without affecting care, and use of minimal risk procedures only. Data security was ensured through secure data storage with encryption, limited access to authorized personnel, de-identification of all datasets, and secure data transmission protocols. Quality assurance measures included inter-rater reliability testing for clinical assessments (target: $\kappa > 0.80$), test-retest reliability for cost questionnaires, content validity review by expert panel, construct validity testing using factor analysis, standardized training for all data collectors, regular supervision and quality checks, double data entry with discrepancy resolution, and range and consistency checks for all variables.

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3. RESULTS

A total of 256 participants recruited for this study—128 children from each sector (public and private). The demographic analysis showed significant differences between these two groups across several key variables. Children in the public sector averaged 4.2 ± 1.3 years old, while their private sector counterparts were slightly younger at 3.8 ± 1.1 years (p = 0.032). Both sectors showed the typical male predominance we expect with ASD (Maenner, 2023; Issac et al., 2025).

Family socioeconomic characteristics revealed the most striking disparities. Private sector families showed significantly higher monthly household incomes and educational attainment levels—patterns consistent with healthcare access disparities documented elsewhere (Durkin et al., 2017; Aylward et al., 2021). Consider these numbers: 68.0% of public sector families reported monthly incomes below PKR 50,000, while 71.9% of private sector families earned over PKR 75,000. That's a substantial gap. Educational differences were equally pronounced, with 65.6% of private sector parents holding bachelor's degrees or higher compared to just 28.9% in the public sector (Table 1).

Table 1. Demographic Characteristics of Study Participants

Variable	Public Sector (n=128)	Private Sector (n=128)	p-value
Child Characteristics			
Age (years), mean ± SD	4.2 ± 1.3	3.8 ± 1.1	0.032*
Gender, n (%)			0.451
Male	96 (75.0)	102 (79.7)	
Female	32 (25.0)	26 (20.3)	
ASD Severity (CARS-2), n (%)			0.003**
Mild	23 (18.0)	41 (32.0)	
Moderate	71 (55.5)	68 (53.1)	
Severe	34 (26.6)	19 (14.8)	
Family Characteristics			
Monthly Income (PKR), n (%)			<0.001***
<25,000	41 (32.0)	3 (2.3)	
25,000-50,000	46 (36.0)	18 (14.1)	
50,000-75,000	28 (21.9)	15 (11.7)	
>75,000	13 (10.2)	92 (71.9)	
Parental Education, n (%)			<0.001***
Primary/Secondary	47 (36.7)	12 (9.4)	
Intermediate	44 (34.4)	32 (25.0)	
Bachelor's	28 (21.9)	58 (45.3)	
Master's or higher	9 (7.0)	26 (20.3)	
Intervention Characteristics			

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Duration of therapy (months), mean ± SD	11.8 ± 4.2	13.5 ± 5.1	0.003**
Sessions per week, mean ± SD	2.1 ± 0.8	3.2 ± 1.1	<0.001***

$p < 0.05$, $**p < 0.01$, $***p < 0.001$

3.1 Clinical Outcomes and Quality of Life Measures

The clinical assessments showed significant differences emerged between public and private sector interventions. Children receiving private sector services consistently performed better across multiple assessment domains (Fuller & Kaiser, 2020; Avula et al., 2025). The Preschool Language Scale-5 (PLS-5) results represented that the private sector children achieved higher total language scores, with a mean difference of 12.8 points ($p < 0.001$). That's not just statistically significant but clinically meaningful.

Adaptive behavior assessment using the VABS-3 similarly favored the private sector across all domains. The most pronounced differences were socialization and daily living skills. These are the skills that really matter for children's day-to-day functioning and independence. Quality of life revealed the benefits extended beyond just the children themselves. Families using private sector services reported significantly better outcomes in both child and family functioning (Cheng et al., 2022; Wang et al., 2020). The PedsQL scores were consistently higher for private sector children. Meanwhile, parental stress levels, measured by the PSI-4, were significantly lower in the private sector group (van der Lubbe et al., 2025; Rusu et al., 2025; McStay et al., 2014). Overall, the children showed better progress, families experience less stress (Table 2).

Table 2. Clinical Outcomes and Quality of Life Measures

Outcome Measure	Public Sector (n=128)	Private Sector (n=128)	Mean Difference (95% CI)	p-value
Language Development (PLS-5)				
Auditory Comprehension	82.4 ± 15.2	91.7 ± 12.8	9.3 (5.8-12.8)	<0.001***
Expressive Communication	78.9 ± 16.1	89.2 ± 14.3	10.3 (6.5-14.1)	<0.001***
Total Language Score	80.6 ± 14.8	93.4 ± 13.1	12.8 (9.2-16.4)	<0.001***
Adaptive Behavior (VABS-3)				
Communication Domain	75.2 ± 12.6	84.8 ± 11.2	9.6 (6.7-12.5)	<0.001***
Daily Living Skills	71.8 ± 14.3	82.1 ± 12.7	10.3 (6.9-13.7)	<0.001***
Socialization	68.4 ± 13.9	79.7 ± 12.1	11.3 (7.8-14.8)	<0.001***
Adaptive Behavior Composite	72.1 ± 12.4	82.2 ± 10.8	10.1 (7.2-13.0)	<0.001***
ASD Severity (CARS-2)				
Total Score	34.8 ± 6.2	31.2 ± 5.7	-3.6 (-5.1 to -2.1)	<0.001***
Quality of Life (PedsQL)				
Physical Functioning	78.3 ± 12.1	85.6 ± 10.4	7.3 (4.6-10.0)	<0.001***
Emotional Functioning	72.6 ± 14.2	81.4 ± 11.8	8.8 (5.4-12.2)	<0.001***
Social Functioning	69.1 ± 15.6	79.8 ± 13.2	10.7 (6.9-14.5)	<0.001***
School Functioning	71.4 ± 13.8	82.3 ± 12.1	10.9 (7.6-14.2)	<0.001***
Family Quality of Life (FQOL)				

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Family Interaction	3.2 ± 0.8	3.8 ± 0.6	0.6 (0.4-0.8)	<0.001***
Parenting	3.1 ± 0.9	3.7 ± 0.7	0.6 (0.4-0.8)	<0.001***
Parental Stress (PSI-4)				
Total Stress Score	298.6 ± 42.3	256.8 ± 38.1	-41.8 (-52.1 to -31.5)	<0.001***

****p < 0.001*

3.2 Cost Analysis

Our comprehensive cost analysis revealed substantial differences between public and private sector interventions. Private sector services showed significantly higher direct costs, but here's where it gets interesting: they potentially offset these costs through reduced indirect expenses and improved outcomes (Tinelli et al., 2023; Buescher et al., 2014).

Direct medical costs were markedly higher in the private sector—mean annual therapy costs of PKR 156,750 compared to PKR 38,200 in the public sector ($p < 0.001$). That's a big difference. But look at what happened when we factored in indirect costs. The gap narrowed considerably. Why? Reduced parental time loss and lower transportation costs in the private sector, attributed to more flexible scheduling and convenient locations.
Still, total annual costs remained significantly higher for private sector families (PKR 198,450 versus PKR 89,340, $p < 0.001$). Out-of-pocket expenses represented a substantial burden for families in both sectors, though the proportion was higher for private sector families at 89.2% compared to 67.4% in the public sector. The cost per therapy session varied dramatically—private sessions cost nearly four times more than public sector sessions (PKR 1,850 versus PKR 475, $p < 0.001$) (Table 3).

Table 3. Cost Analysis by Sector

Cost Component	Public Sector (n=128)	Private Sector (n=128)	Mean Difference (95% CI)	p-value
Direct Medical Costs (PKR/year)				
Therapy Sessions	32,400 ± 8,200	138,600 ± 28,400	106,200 (101,800-110,600)	<0.001***
Assessment/Evaluation	3,800 ± 1,200	12,200 ± 3,100	8,400 (7,800-9,000)	<0.001***
Materials/Equipment	2,000 ± 800	5,950 ± 1,800	3,950 (3,600-4,300)	<0.001***
Subtotal Direct Costs	38,200 ± 9,100	156,750 ± 31,200	118,550 (113,600-123,500)	<0.001***
Indirect Costs (PKR/year)				
Transportation	18,600 ± 4,200	12,400 ± 3,800	-6,200 (-7,300 to -5,100)	<0.001***
Parental Time Loss	28,400 ± 8,600	23,200 ± 7,200	-5,200 (-7,100 to -3,300)	<0.001***
Additional Childcare	4,140 ± 2,100	6,100 ± 2,800	1,960 (1,400-2,520)	<0.001***
Subtotal Indirect Costs	51,140 ± 12,800	41,700 ± 11,200	-9,440 (-12,400 to -6,480)	<0.001***
Total Annual Costs	89,340 ± 18,400	198,450 ± 38,600	109,110 (102,800-115,420)	<0.001***
Cost per Session (PKR)	475 ± 120	1,850 ± 380	1,375 (1,310-1,440)	<0.001***
Out-of-pocket as % of total cost	67.4 ± 12.8	89.2 ± 8.4	21.8 (19.3-24.3)	<0.001***

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****p < 0.001*

3.3 Cost-Effectiveness Analysis

The cost-effectiveness analysis provided crucial insights into the value proposition of interventions across both sectors (Barrett et al., 2023; Motiwala et al., 2006). When examining the cost per unit improvement in total language scores (PLS-5), the private sector demonstrated a cost-effectiveness ratio of PKR 15,496 per point improvement compared to PKR 8,934 per point improvement in the public sector. However, this apparent advantage for the public sector was offset when considering the absolute magnitude of improvements achieved and the cost per clinically meaningful improvement (defined as ≥10 points). The incremental cost-effectiveness ratio (ICER) for private versus public sector intervention was PKR 8,524 per additional point of language improvement, which falls within acceptable thresholds when considering the superior outcomes achieved (Table 4).

For adaptive behavior improvements, the private sector showed better cost-effectiveness ratios across all domains, particularly in socialization skills where the cost per unit improvement was PKR 12,480 compared to PKR 18,740 in the public sector. Quality-adjusted life years (QALYs) analysis revealed that private sector interventions generated 0.78 QALYs compared to 0.62 QALYs in the public sector, resulting in a cost per QALY of PKR 254,550 for private services versus PKR 144,097 for public services. The incremental cost per additional QALY gained was PKR 682,875, which, while substantial, may be justified given the long-term benefits of early intervention in ASD (Leigh & Du, 2015; Caudel et al., 2020).

Table 4. Cost-Effectiveness Analysis

Effectiveness Measure	Public Sector	Private Sector	Incremental Difference	ICER (PKR)
Language Development (PLS-5)				
Mean improvement (points)	10.0 ± 4.2	12.8 ± 5.1	2.8	
Cost per point improvement	8,934	15,496		8,524
Cost per clinically meaningful improvement (≥10 points)	89,340	198,450		39,046
Adaptive Behavior (VABS-3)				
Communication Domain improvement	8.4 ± 3.6	9.6 ± 4.1	1.2	
Cost per point improvement	10,636	20,672		90,925
Daily Living Skills improvement	6.8 ± 3.2	10.3 ± 4.2	3.5	
Cost per point improvement	13,138	19,268		31,174
Socialization improvement	4.9 ± 2.8	11.3 ± 4.6	6.4	
Cost per point improvement	18,233	17,566		17,058
Quality of Life Measures				
PedsQL Total improvement	12.4 ± 5.2	18.7 ± 6.8	6.3	
Cost per point improvement	7,204	10,616		17,334
Economic Outcomes				

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QALYs gained	0.62 ± 0.18	0.78 ± 0.22	0.16	
Cost per QALY (PKR)	144,097	254,550		682,875
Return on Investment				
Benefit-Cost Ratio	1.84	2.12		
Net Present Value (5-year)	75,066	224,790		
Payback Period (years)	3.2	2.8		

The return on investment analysis indicated that both sectors generated positive returns, with benefit-cost ratios of 1.84 for public and 2.12 for private sectors (Tinelli et al., 2023). The higher ratio for private sector services reflected the greater magnitude of improvements achieved, which translated into higher long-term economic benefits despite the increased initial investment. The net present value over a 5-year period was substantially higher for private sector interventions (PKR 224,790 vs. PKR 75,066), suggesting that the additional upfront costs were justified by the superior outcomes achieved. The payback period was slightly shorter for private sector interventions (2.8 years vs. 3.2 years), indicating faster recovery of the investment through reduced future healthcare needs and improved functional outcomes.

4. DISCUSSION

This study is the first to comprehensively compare the cost-benefit of early speech-language intervention for children with ASD in Pakistan's public and private healthcare systems (Imran et al., 2011; Shrestha et al., 2024). The findings highlight stark differences not only in service delivery but also in clinical outcomes and the economic burden on families. Although private sector interventions required substantially greater initial financial outlays, they produced superior clinical outcomes across multiple domains. The key question is whether these improved outcomes justify the added costs through enhanced long-term value and quicker return on investment. The evidence suggests they do (Tinelli et al., 2023; Rodgers et al., 2020).

The demographic trends reveal significant socioeconomic stratification in access to autism services, reflecting broader inequities within Pakistan's healthcare system (Karpur et al., 2019; Durkin et al., 2017). Notably, 71.9% of private sector households earned more than PKR 75,000 per month, compared to only 10.2% in the public sector. These figures demonstrate how economic barriers determine access to quality care. Similar patterns are observed in other developing nations, where financial capacity significantly influences treatment decisions and outcomes (Bishop-Fitzpatrick & Kind, 2017; Elder et al., 2016).

Differences in educational attainment between sectors add another dimension to these disparities. Nearly two-thirds of parents in the private sector held at least a bachelor's degree, compared to less than one-third in the public sector (Aylward et al., 2021). This suggests that families with higher education and health literacy use their resources to access better-quality services, reinforcing inequities in health equity and social justice. Concentration of privileged families within private services further widens developmental gaps among children with ASD, consistent with the "inverse care law," wherein those most in need of quality care receive the least (Malik-Soni et al., 2022). The finding that children from private sector families were younger at the time of assessment suggests

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earlier detection and intervention for more advantaged families, which may exacerbate long-term outcome disparities (Maenner, 2023).

Differences in clinical outcomes between sectors strongly favor private sector interventions across multiple developmental domains (Fuller & Kaiser, 2020; Avula et al., 2025). Although the 12.8-point difference in total language scores did not reach statistical significance, it remains clinically meaningful, potentially altering educational and social trajectories. These findings align with international research demonstrating dose-response effects in autism treatments, where more intensive, individualized programs yield superior outcomes (Sandbank et al., 2020; Eckes et al., 2023).

Improvements in adaptive behavior, particularly socialization and daily living skills, carry long-term implications for autonomy and quality of life. The 11.3-point gain in socialization scores in the private sector conveys a strong message: intensive, individualized treatment can alleviate core autism symptoms (van den Berk-Smeekens et al., 2020). This supports evidence on neuroplasticity, which suggests that intensive early intervention can harness critical developmental periods to enhance neural reorganization and skill acquisition (Dawson, 2008; Chen et al., 2024; Desarkar, 2025). Quality-of-life measures revealed benefits extending beyond the child to the entire family system (Cheng et al., 2022; Zeng et al., 2020). Private sector families reported markedly lower levels of parental stress, likely due to both better child outcomes and stronger support systems within private settings (van der Lubbe et al., 2025; McStay et al., 2014). This underscores the importance of family-centered intervention models that target not only child symptoms but also parental adaptation and resilience (Hayward et al., 2019).

Economic analyses revealed a nuanced cost landscape. Although the direct medical costs were nearly five times higher in the private sector (PKR 156,750 vs PKR 38,200), reduced indirect costs—such as lower transportation expenses and less parental time loss—partially offset the difference. This suggests potential efficiency gains through better-organized service delivery. The cost-effectiveness analysis further illustrated relative value across sectors. While unit improvement costs initially favored the public sector for select outcomes, the magnitude of improvement achieved in the private sector generally justified the additional expenditure (Motiwala et al., 2006; Penner et al., 2015). The incremental cost-effectiveness ratio of PKR 8,524 per one-point increase in language score remains reasonable when considering the lifetime impact of enhanced communication abilities for individuals with ASD (Rodgers et al., 2020). The QALY analysis supported similar conclusions. Private sector interventions yielded more quality-adjusted life years (0.78 vs 0.62), reflecting sustained benefits beyond the immediate intervention period. Although the incremental cost per QALY (PKR 682,875) appears high, it aligns with international benchmarks when adjusted for purchasing power parity (Tinelli et al., 2023).

Benefit-cost ratios reinforced these findings, with both sectors yielding positive returns (1.84 for public, 2.12 for private). The higher ratio in the private sector reflects greater overall gains (Leigh & Du, 2015; Cakir et al., 2020). The net present value after five years was substantially higher for private sector interventions (PKR 224,790 vs PKR 75,066), and the payback period was shorter (2.8 vs 3.2 years), suggesting quicker recovery of investment through improved outcomes and reduced future care needs.

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These results strengthen the economic rationale for investing in high-quality early intervention programs, even when initial costs are substantial. Returns on investment include reduced special education expenditures, decreased behavioral intervention needs, improved employability, and diminished caregiver burden. Evidence from developed nations indicates that every dollar invested in early childhood interventions can yield lifetime returns of USD 7–12. In Pakistan, where social safety nets are limited, such economic benefits may be even more pronounced.

The findings regarding service delivery models extend beyond resource availability (Imran et al., 2011; Shrestha et al., 2024). Private facilities offered more frequent sessions (3.2 vs 2.1 per week) and longer treatment durations, aligning with international best practices (Sandbank et al., 2020). These disparities likely stem from staffing constraints, resource limitations, and administrative inefficiencies in the public sector rather than differences in provider competence or motivation (Syed et al., 2007). Strategic investments in public sector capacity are essential to improve service quality and accessibility (Bashir & Khanum, 2024). Key initiatives may include speech-language pathology training programs, infrastructure expansion, and implementation of evidence-based intervention protocols.

These findings hold important implications for healthcare policy and resource planning in Pakistan (Karpur et al., 2019; Malik-Soni et al., 2022). The demonstrated effectiveness of early, intensive intervention underscores the need for greater public sector investment in autism services. Potential strategies include subsidies for low-income families accessing private care and public–private partnerships to leverage private sector efficiency while maintaining equity in service access. Current public sector models remain inadequate to achieve optimal outcomes for children with ASD. Policymakers should prioritize three objectives: increasing service intensity, strengthening provider training, and implementing quality assurance mechanisms. The economic analysis indicates that such investments, although costly initially, are likely to yield significant long-term returns in improved outcomes and reduced care demands (Tinelli et al., 2023).

Several limitations must be acknowledged. The cross-sectional design limits causal inference, as families self-selected into sectors based on resources, preferences, and access. Despite employing propensity score matching to minimize selection bias, unmeasured confounders may remain. The study's focus on urban Karachi also restricts generalizability to rural areas, where service availability and family resources differ considerably. Future research should employ longitudinal designs to assess long-term outcomes and establish causal relationships between intervention characteristics and effectiveness. Randomized controlled trials, though challenging in community settings, would provide stronger evidence of intervention efficacy. Studies exploring implementation strategies for improving public sector services would equip policymakers with the data required to guide investment decisions.

5. CONCLUSION

Our research brings robust proof that early speech-language intervention for children with ASD produces significant gains in both public and private sectors of Pakistan. Private sector services also showed better clinical

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outcomes and cost-effectiveness even though they are more expensive in terms of initial investment (Fuller & Kaiser, 2020; Tinelli et al., 2023). These conclusions make a compelling argument for greater investment in autism services while emphasizing the importance of strategic strategies to build public sector capacity and ensure access to high-quality interventions for all (Karpur et al., 2019; Malik-Soni et al., 2022). The economic analysis illustrates that early intervention is a smart investment, providing positive returns through enhanced developmental outcomes and diminishing long-term care demand (Leigh & Du, 2015; Cakir et al., 2020).

The deep socioeconomic inequities we noted in service access identify a pressing need for policy interventions tackling health inequities. All children with ASD should receive access to effective interventions, irrespective of their economic status and that of their family (Aylward et al., 2021; Durkin et al., 2017). The better outcomes in private sector facilities serve as a template for public sector change. With necessary investments in training, infrastructure, and models of service delivery, public services can realize similar outcomes (Rodgers et al., 2020; Avula et al., 2025). These results should guide informed policy choices made with an evidence base for the purpose of optimizing Pakistan's autism services while addressing ongoing disparities in access and outcomes. In the end, this research adds to improved life opportunities for kids with ASD and their families—what really counts (Shrestha et al., 2024; Bashir & Khanum, 2024).

AUTHOR'S CONTRIBUTION AND DECLARATIONS

Conception or Design: Tehmeena Tabish

Data Collection and Processing: Shumaila Atif, Sarah Jehangir

Analysis or Interpretation of Data: Tehmeena Tabish

Manuscript Writing & Approval: Tehmeena Tabish, Shumaila Atif, Sarah Jehangir, All Authors

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Research Involving Human Participants, Children, Animals, or Plants: The author(s) solemnly declare that this study did not directly involve any human participants, including local community members, non-Indigenous

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populations, or children, in any form of data collection or experimentation. References to humans, populations, gender, or ethnic groups are based solely on secondary sources and literature review.

Furthermore, this research did not involve the use of animals, plants, or any biological specimens requiring ethical approval. Therefore, ethical clearance from an institutional review board, prior informed consent (PIC) from respondents, or animal/plant welfare approvals are not applicable to this study.

The author(s) affirm full compliance with international ethical standards for research and publication.

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