

MACHINE LEARNING TECHNIQUES FOR IDENTIFYING SELF-CARE PROBLEMS IN DISABLED CHILDREN

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ABSTRACT:- The identification and intervention of self-care problems in disabled children are crucial for enhancing their quality of life and independence. The utilization of machine learning algorithms holds promise in revolutionizing the identification and handling of these self-care challenges potentially offering tailored solutions to improve the well-being and autonomy of disabled children. Therefore, a literature review is imperative to comprehensively assess the landscape of machine learning (ML) applications in addressing these self-care challenges. Existing SLRs on this topic lack comprehensive coverage of ML-based techniques, hindering a full understanding of their efficacy in classifying self-care issues among disabled children. This review aims to assess that how ML methodologies contribute to identify and address these challenges along with their impacts on accuracy and clinical relevance. By encapsulating various ML methodologies used in diagnosing self-care problems, this review reveals their diverse impacts on accuracy and clinical applicability. The novel aspect of this work lies in the comprehensive coverage and evaluation of diverse ML techniques, highlighting their potential to transform pediatric healthcare for disabled children. In conclusion, this review demonstrates that hybrid ML models, feature selection and extraction techniques significantly enhance classification accuracy paving the way for improved interventions. This comprehensive analysis makes this review a valuable resource for researchers seeking insights into ML's role in addressing self-care challenges among disabled children.

Index terms—Self-care, Disabled Children, Machine Learning.

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INTRODUCTION

Physical disability refers to bodily conditions impacting an individual's ability to sustain prolonged mental or physical effort affecting their mobility and competency. Major causes encompass trauma, birth complications, and genetic disorders, leading to long-term impairment or dysfunction in body function. Such disabilities often restrict personal activities. Diagnosing physical and motor disabilities is a complex task often necessitating expert occupational therapists. Collecting characteristics of children with disabilities is crucial, leading to the development of the ICF-CY (International Classification of Functioning, Disability, and Health - Children & Youth), widely employed for disability analysis. The ICF framework facilitates evaluating issues related to personal care, mobility, and home life through specific inquiry forms. Activities such as eating, self-washing, and body part care fall under the scope of self-care in the ICF-CY typically spanning from birth to around 7 years of age [14].

Identifying and addressing self-care problems in disabled children is a pivotal aspect of enhancing their quality of life and autonomy. Inadequate diagnosis and care exacerbate the challenges children face in adapting

to their disabilities. Those with physical and motor disabilities encounter numerous hurdles in their daily routines emphasizing the crucial need for accurate classification of self-care issues. However, achieving this classification demands well-trained individuals and a significant investment of time [16].

Machine learning technologies have expanded in various fields in recent years, finding applications in economics, biomedical contexts, intrusion detection, traffic classification and medical diagnosis. Leveraging the ICF-CY framework, machine learning can help in categorizing self-care problems among children [14]. Children grappling with disabilities encounter multiple hurdles especially concerning activities fundamental to their daily lives. From basic motor skills to personal care routines, these children often confront substantial barriers that impede their independence and quality of life. The utilization of machine learning algorithms holds promise in revolutionizing the identification and handling of these self-care challenges potentially offering tailored solutions to improve the well-being and autonomy of disabled children [1].

In literature, numerous methodical review papers exist to explore the techniques to classify self-care problems in disabled children. However, the reviews

specifically focusing on ML based techniques to solve this problem and having generalized scope are noticeably scarce. The only available review on this topic tends to be informal and covers only one type of disability classification. Therefore, to bridge the gap in research, this paper aims to provide a comprehensive overview of the current landscape in leveraging machine learning techniques for the identification and intervention of self-care problems in disabled children. By examining a spectrum of studies, methodologies, and technological advancements in this domain, this review endeavors to shed light on the efficacy and limitations associated with employing machine learning in this critical area of pediatric healthcare. Understanding these aspects is crucial in utilizing the full capabilities of technology to enhance the lives of disabled children through targeted and responsive interventions addressing their self-care needs.

LITERATURE REVIEW

Children facing motor or physical disabilities encounter numerous challenges with everyday activities. Hence, accurately identifying self-care issues becomes incredibly important [16]. Many researchers have worked on this problem and have proposed techniques to classify self-care problem in children with disabilities. To provide the research community, a review of existing classification techniques, numerous review papers exist covering this problem.

In [1], Authors have conducted a systematic review to carefully evaluate the proof behind self-management approaches for kids and teens with physical disabilities. The aim of this review was to find real-life studies that checked how well self-management programs worked for kids and teens in school who have physical disabilities. Authors have adhered to the guidelines from the preferred reporting items for systematic reviews and meta-Analyses to ensure a clear and comprehensive report. The results produced by this study indicate that there wasn't much strong evidence supporting self-management programs for young people with physical disabilities. While these programs have potential to enhance knowledge and health habits, caution is advised for clinicians, youth, and families when adopting these strategies. It's suggested to develop new interventions using more careful methods for better results [1].

In [2], Edwards, D. *et. al.* have conducted a study using theories and different methods to review information, aiming to find out how well interventions work and to gather thoughts from children, parents, and experts about what makes it easier or harder for kids and young adults aged 3–25 to take good care of their diabetes at school and college. Enhancements in diabetes management could be achieved through the complete implementation and assessment of guideline impact.

However, the evidence remains constrained by quality limitations, highlighting gaps in our understanding of effective strategies. While telemedicine between healthcare providers and schools, along with school nurse support, has proven effective in certain scenarios, the absence of onsite nurses in various educational systems poses challenges. The pursuit of more inventive and enduring solutions, accompanied by rigorous evaluations, becomes imperative. Moreover, there's a need for the continued development and evaluation of comprehensive lifestyle approaches tailored to college/university students. It remains crucial to empower children for optimal management of exercise, diet, blood glucose monitoring, and insulin regimes within the school environment, while young individuals self-manage during their college/university years. This methodologically rich mixed-method systematic review endeavors to ascertain intervention effectiveness and amalgamate the perspectives of children, parents, and professionals, outlining barriers and facilitators in achieving optimal management of diabetes and self-care for individuals aged 3–25 years within educational settings [2].

In [3], authors have explored theories and models related to self-care among young individuals living with chronic conditions like asthma or type 1 diabetes. It gathers key aspects from various papers to create a new comprehensive model highlighting how young individuals transition from relying on family members to becoming the main decision-makers in their self-care journey. This holistic model gives a broader understanding of the world these young individuals with chronic conditions face. Therefore, healthcare teams must provide self-care-focused support throughout their growth. Young individuals dealing with chronic conditions experience significant personal, family, and social changes, making it vital for healthcare professionals to understand and guide them. This review can aid in designing interventions that promote self-care among these individuals and their families.

In [4], The authors aimed to examine published material, including both official publications and less formal sources, discussing self-management, self-care, and self-help concepts applicable to adolescents facing emotional challenges. While emotional issues are increasingly prevalent among adolescents, access to specialized mental health care is often limited to those with more severe conditions. Adolescents might utilize self-care strategies while awaiting treatment or to prevent relapse. As definitions in adolescent mental health contexts are unclear and somewhat overlapping, a thorough review of available literature was necessary to bring clarity. The research focused on studies involving adolescents aged 10 to 19 experiencing emotional symptoms. These studies explored self-management, self-care, or self-help methods used by this population without involving mental health professionals. The

review included various types of studies—quantitative, qualitative, economic, mixed methods, systematic, scoping, and literature reviews—published in English from 2000 onwards[4].

In [5], authors have performed a systematic review to examine the latest scientific evidence related to ML models utilized for categorizing children with autism spectrum disorder (ASD). The authors have extensively discussed 11 papers focused on using ML techniques and children's social visual attention (SVA) for early ASD assessment. The evidence indicates ML's significance in

this context, potentially serving as a reliable biomarker-based approach for an objective diagnosis. The review also addresses limitations and suggests future directions for this area of study.

Most of the surveys in literature are based on traditional approaches and the scope of these surveys is limited to only one type of disability. We have found only one for ML based approaches but the scope of that survey is also limited to autism disorder based approaches. The comparison of existing surveys with this survey has been given in Table 1.

Table I. The Comparison of Existing Surveys with this Survey

Ref. No.	Year	Survey Approach	Methodologies Covered (Traditional/ML based)	Type of Disability Covered	Age Groups
[1]	2014	Systematic Review	Traditional Approaches	Physical Disability	Age 6-18
[2]	2014	Systematic Review	Traditional Approaches	Type-1 Diabetes	Age 3-25
[3]	2021	Systematic Review	Traditional Approaches	Pediatric Patients with Chronic Conditions	Age 0-24
[4]	2023	Formal	Traditional Approaches	Emotional Problems	Age 10-19
[5]	2021	Systematic Review	Machine Learning Approaches	Autism SpectruDisorder	Not Mentioned
This Study	2023	Formal	Machine Learning Approaches	Multiple Types of Disabilities	Dynamic

METHODOLOGY

The methodology for this review paper involved an extensive search across key scholarly databases using targeted keywords like "machine learning," "self-care," and "disabled children." The search focused on identifying studies centered on machine learning techniques applied to classify self-care problems in children with disabilities. Selected papers underwent a meticulous review process to extract essential parameters including the employed machine learning algorithms, dataset used and its availability and evaluation metrics. A systematic tabular format was then adopted to organize and synthesize these parameters facilitating a comparative analysis across studies. This tabulation serves as a comprehensive reference to elucidate the diverse methodologies and outcomes within the realm of machine learning for addressing self-care issues in disabled children.

A. **Overview of selected studies:** In [6], a novel deep learning based solution named Care2Vec has been proposed to address the classification challenge in self-care. Leveraging a genuine dataset of self-care activities aligned with the World Health Organization's International Classification of Functioning, Disability and Health for Children and Youth (ICFCY), deep learning is employed. The proposed method, Care2Vec, operates as a hybrid autoencoder-based approach, utilizing autoencoders and DNN in a modeling based on two-steps. To evaluate the approach, a comparison is made against conventional methods documented in existing

literature, encompassing DNN and DT, in both binay and multi-class classification scenarios using k-fold cross-validation. Evaluation criteria involve AUC, accuracy and mean.

In [7], authors have presented a sturdy framework utilizing extreme gradient boosting (FSX) and a sampling technique to enhance prediction accuracy concerning the SCADI dataset. Initially, the model transforms the dataset into a reduced-dimensional dataset. Subsequently, the proposed framework balances this new dataset using sampling techniques with varying ratios. FSX is then employed to diagnose the identified problems. To exhibit the efficacy of FSX and analyze the outcomes, experiments assessing prediction accuracy and feature importance were conducted. The experimental outcomes demonstrate the superiority of FSX utilizing the Synthetic Minority Over-sampling Technique (SMOTE) compared to approaches such as ANN, SVM, and RF for the SCADI dataset. The suggested framework attains an 85.4% overall accuracy, demonstrating a significantly high level of performance well-suited for categorizing self-care issues in medical diagnoses.

In [8], the authorshave introduced a predictive model named GA-XGBoost, merging XGBoost with genetic algorithms (GAs) to anticipate self-care issues in children with disabilities. The selection of specific features greatly impacts the model's effectiveness, leading us to employ GA for optimizing the identification of ideal feature subsets, thereby enhancing the performance of model. To test the efficiency of GA-XGBoost's, six experiments were conducted. They compared their results with alternative machine learning

models and previous study findings using statistical significance tests. These tests assessed the influence of feature selection by comparing it with other techniques and conducting sensitivity analyses on GA parameters. Results demonstrate that GA-XGBoost outperforms other prediction models and previous research findings. Furthermore, a web-based tool is developed for self-care prediction to aid therapists in diagnosing self-care issues in children with disabilities. This tool aims to facilitate tailored treatment and therapy for each child, thereby improving their therapeutic outcomes.

In [9], an ML-based selection framework has been proposed that operates in two phases first step is establishing an inclusive disability ontology for selecting assistive services and the second phase is generating semi-synthetic datasets for disability services.

Initially, it evaluates all accessible atomic tasks to assess their appropriateness concerning the user's objectives and profiles. Subsequently, it narrows down the selection of service providers by aligning their quality-of-service factors with the context and specifics of the disabled individual. The methodology revolves around diverse user characteristics, encompassing their disability profile, preferences, environment, and available IT resources. To enrich the extensively used QWS V2.0 and WS-DREAM web services datasets, the authors expanded them by merging selected accessibility features. To validate the effectiveness of this approach, a comparison was conducted against common multi-criteria decision-making (MCDM) models such as AHP, SAW, PROMETHEE, and TOPSIS. The findings highlighted the superior accuracy of the proposed service selection process compared to these methods, ensuring the fulfillment of accessibility requirements.

In [10], authors have proposed an effective framework for evaluating various ML techniques aimed at ASD detection at an early stage. The framework utilizes four Feature Scaling strategies including Power Transformer (PT), Quantile Transformer (QT), Max Abs Scaler (MAS) and Normalizer. Subsequently, the feature scaled datasets undergo classification by using eight simple but impactful ML algorithms—RF, Ada Boost, KNN, DT, GNB, Logistic Regression (LR), Linear Discriminant Analysis (LDA) and SVM. Experiments have been conducted on four benchmark ASD datasets (Children, Toddlers, Adults Adolescents). The evaluation of classification results employs different statistical measures such as ROC curve, accuracy, precision, F1-score, MCC, recall, Log Loss and Kappa score. This analysis identifies the best-performing classification methods and the most suitable FS methodology for each ASD dataset. Results show that AB achieves the highest accuracy in predicting ASD, with 99.25% for Toddlers and 97.95% for Children. LDA exhibits the highest accuracy of 97.12% for Adolescents and 99.03% for adults. These peak accuracies are observed when scaling

children and toddlers with the normalizer FS method and employing the QT FS method for Adolescents and Adults.

In [11], an innovative expert model for classifying self-care problems in children with physical and motor disabilities has been introduced. This model integrates a Probabilistic Neural Network (PNN) as the classifier and leverages the Genetic Algorithm (GA) for feature selection. The utilization of PNN is centered on training with a standard ICF-CY dataset, a comprehensive framework used by occupational therapists to evaluate numerous features crucial in diagnosing self-care problems. Recognizing the varying impact of these features on classification based on occupational therapists' experiences, GA is employed to pinpoint pertinent and pivotal features for effective self-care problem classification. Given the importance of classification rules for occupational therapists, additional extraction of self-care problem classification rules is conducted using the CART algorithm. Experimental results demonstrate notable enhancements in classification accuracy and reduced time complexity through the feature selection algorithm compared to alternative models. The proposed model achieves a 94.28% accuracy in classifying self-care problems in children while utilizing only 16.5% of all available features.

In [12], the authors aimed to accurately classify self-care issues in children with disabilities through the utilization of DNN with minimal error. Multiple DNN models were constructed, considering various parameters such as the number of hidden layers, neurons in these layers, activation functions, optimization and loss algorithms, and epoch values. These models were tested and trained using the SCADI (Self-Care Activities Dataset based on ICFCY) dataset. The performance of these models was evaluated using metrics including precision, F-1 score, accuracy and recall. Detailed descriptions of the top-performing 8 models are provided. The findings highlight the DSA-1 model as delivering the best classification performance employing the Elu activation function, Adadelat optimization algorithm and Categorical cross-entropy loss function. This model achieves perfect scores of 1 for P, R, ACC, and F1, predicting self-care skill problems in children with motor and physical disabilities with 100% accuracy. Moreover, to enhance the credibility of the top three models (DSA-1, DSA-2, and DSA-3), a 10-fold cross-validation method was employed during training and testing. The mean accuracy through cross-validation was computed at 85.71%, 85.71%, and 87.14%, correspondingly.

In [13], an expert model utilizing a SVM and a rule-based classifier to forecast self-care issues among children and youth with physical and motor disabilities at an earlier stage has been introduced. The SCADI dataset,

the sole available resource, was employed. This dataset comprises an extensive array of features. However, handling numerous features often leads to space, time and performance inefficiencies. To address this, dimensionality reduction techniques were employed to pinpoint pertinent features essential for the models. The Boruta algorithm facilitated feature selection. The SVM model was constructed utilizing the entire dataset and a subset of 48 selected features, implemented in R Programming. The model demonstrated superior performance, achieving 97.14% accuracy when operating on the selected attributes compared to using all attributes. This expert system holds promise in aiding therapists to identify issues faced by children with exceptionalities, thereby assisting in early problem recognition and intervention.

In [14], authors have proposed improved expert system utilizing ML techniques for diagnosing and categorizing self-care challenges in children dealing with both mental and physical disorders. The research aimed to enhance prediction accuracy for the SCADI dataset concerning self-care/personal-care issues in children. The proposed approach employed PM-PSO as an attribute selector to identify the most relevant attributes. Using this refined method, classifiers like Naïve Bayes, MLP, C 4.5, and random tree were employed to assess performance metrics. The performance of the proposed feature selector was contrasted with that of PCA. The simulation outcomes demonstrated that PM-PSO notably improved the accurate prediction of instances: 14.29% for Random Tree, 11.43% for MLP, 11.43% for C 4.5, and 1.42% for Naïve Bayes surpassing PCA's performance. In various metrics, PM-PSO consistently exhibited enhanced performance compared to PCA.

In [15], Choudhury, A., & Greene, C. have introduced a predictive model designed to categorize self-care issues within the Self-Care Activities Dataset based on the ICF-CY framework. The dataset comprises 206 attributes collected from 70 children dealing with motor and physical disabilities. Authors have employed and compared various algorithms—RF, SVM, NB, Lazy Locally Weighted Learning and Hoeffding Tree—using a two-tailed T-test at a 95% confidence interval. The Boruta algorithm, utilized in this research, reduces data dimensionality to identify the most essential predictors. Among these algorithms, Random Forest exhibits the highest classification accuracy at 84.75%. The authors suggest that integrating predictive analytics could enhance the utilization of ICF-CY by automating the classification associated with disability, functioning, and health.

In [16], Zdrodowska, M., & Dardzińska-Głębocka, A. have worked to derive classification and action rules that can assist professionals working with children having disabilities. It starts by identifying the features impacting classification accuracy. After that, two

models have been developed—one inclusive of all features and another with selected features—to extract rules for classification. Action rules are also generated to predict the subsequent steps in the treatment process. The resulting model, chosen attributes and the action rules and extracted rules for classification aim to aid therapists in directing their efforts toward areas where even a slight improvement could significantly benefit children with disabilities.

In [17], authors have presented an all-encompassing classification framework designed to identify pathological disorders in children. It involves an examination of real data to assess the predictive accuracy of various classification algorithms for detecting seven distinct pathological conditions. The study comprises an experimental analysis that elaborates on the performance of individual algorithms. This framework holds potential for early disease detection and the recommendation of suitable preventive measures. Additionally, it enables a more detailed understanding of a patient's demographic profile concerning their pathological conditions, facilitating the recommendation of tailored treatments.

In [18], authors have proposed an expert system leveraging ML to forecast self-care issues in children with motor and physical disabilities. This system utilizes the SCADI, the sole available dataset for this purpose. The proposed method involves merging a PCA-driven approach with diverse ML classification techniques, culminating in the selection of a classifier for the expert system based on performance analysis. The experimental results suggest that KNN surpasses other classifiers, leading to its selection for the expert system. However, due to the dataset's significant imbalance, there's a notable likelihood that members of a specific target group might solely appear in the testing set and not in the training set. This imbalance significantly impacted the overall system performance.

In [19], authors have introduced a data-driven methodology rooted in machine learning to aid human experts in Assessing and categorizing disabilities among children and young individuals assessment procedures. This methodology has been evaluated using a recently released dataset centered on self-care activities aligned with ICF-CY. Besides the original dataset featuring Boolean attributes except for the class, experiments were conducted using the same data formatted into a numeric data model. The quantitative outcomes from the in-depth experimental analysis of this dataset showcase promising comparisons with previous studies. Notably, the BayesNet classifier demonstrated significantly superior accuracy and performance. Additionally, the numeric data model employed in this study consistently yielded more precise classifications across various classifiers, except for specific instances and metrics concerning the multilayer perceptron.

In [20], Autism Spectrum Disorders (ASDs) have a profound impact on individuals' lives, and their global incidence and prevalence are on the rise. Global health organizations and autism-treatment centers face challenges in developing an accurate and early ASD diagnosis system. The lack of clarity on the disease's etiology demands urgent attention to explore its causal factors. Specifically, understanding the role of Characteristics related to society, demographics, and family as risk factors in predicting ASD presents a complex scientific problem. This study tackles this challenge by creating an early prediction model for ASD diagnosis. The model utilizes machine learning (ML) and concentrates on crucial sociodemographic and family characteristic features linked to ASD. The methodology comprises three phases. The initial phase involves identification, utilizing an extensive ASD dataset and preprocessing steps. This includes employing a 1-NN model to handle missing data, utilizing feature-selection methods like Chi2 and Relief, and implementing an adaptive balancing data technique using Synthetic Minority Oversampling Technique. The second phase centers on model development, where the freshly prepared ASD dataset is trained and tested using eight ML methods: DT, RF, NB, kNN, SVM, logistic regression, AdaBoost, and neural network multilayer perceptron (MLP). The third phase assesses the developed model using five metrics: precision, accuracy, recall, AUC, F1-score, and test time in seconds. Key findings include the extraction of seven highly effective characteristics related to society, demographics, and family related to autism cases out of ten identified features. Correlation sensitivity analysis reveals notable relationships, such as age of mother at child birth having the highest positive correlation with age of father at child birth and other correlations. AdaBoost, NN, KNN and DT methods demonstrate higher accuracy, with AdaBoost achieving the best results across multiple evaluation metrics. The study affirms the efficiency of the proposed prediction framework, indicating its potential for early autism prediction. The preprocessing stages significantly improve classification accuracy, and the study concludes that the new balanced ASD dataset can serve as a valuable data source for future autism research.

In [21], It has been discussed that Autism spectrum disorder (ASD) is a neuro developmental condition severely impacting cognitive, linguistic, object recognition, communication, and social abilities. While ASD is not curable, early detection is crucial for mitigating its effects. This study proposes a machine learning model leveraging artificial intelligence (AI) techniques to enhance ASD detection across different age groups. Datasets for toddlers, children, adolescents, and adults were collected, and various feature selection techniques were applied. Different classifiers were then

employed, and performance was assessed using metrics such as predictive accuracy, kappa statistics, fl-measure, and AUC. Additionally, individual classifier performance was analyzed using non-parametric statistical tests. SVM outperformed other classifiers, achieving 99.61% accuracy for the Correlation-based Feature Selection (CFS), 97.82% accuracy for the RIPPER-based toddler subset and Boruta CFS intersect (BIC) method-based child subset, 95.87% accuracy for the Boruta-based adolescent subset, and 96.82% accuracy for the CFS-based adult subset. Further, the Shapley Additive Explanations (SHAP) method was applied to different subsets of features, identifying the features with highest accuracy and ranking based on the analysis.

In [22], this paper suggests employing intelligent hybrid systems that integrate artificial neural networks and fuzzy systems to aid in identifying children with potential issues affecting their motor or cognitive development. The research focuses on identifying diseases outlined in the ICF-CY. To support studies on disease identification, a global database has been made available for researchers to develop techniques and create specialist systems based on fuzzy rules, assisting in detecting potential issues in healthy children. The paper utilizes a sophisticated model capable of generating fuzzy rules to construct a predictive model for diagnosing problems in children or adolescents. The obtained results are promising, demonstrating improved accuracy compared to initial studies and confirming the feasibility of the approach in identifying children with ICF-CY.

In [23], autism spectrum disorder (ASD) is a complex neurological developmental condition with diverse manifestations. Timely diagnosis and appropriate medical intervention significantly enhance the daily lives of children with ASD and their parents. This study explores the utility of static features extracted from facial photographs of autistic children as a potential biomarker for distinguishing them from typically developing children. Five pre-trained CNN models—MobileNet, Xception, EfficientNetB0, EfficientNetB1, and EfficientNetB2—were employed as feature extractors, while a DNN model served as a binary classifier for accurate autism identification. The models were trained on a publicly available dataset containing face images of children diagnosed with autism and controls classified as autistic and non-autistic. Among the models, Xception demonstrated superior performance, achieving an AUC of 96.63%, a sensitivity of 88.46%, and an NPV of 88%. EfficientNetB0 consistently predicted autistic and non-autistic groups with a 59% confidence level, providing valuable insights into autism detection.

In [24], The categorization of self-care abilities in children facing physical disabilities presents a substantial and intricate challenge, necessitating the expertise of occupational therapists. In contemporary decision-making, data-driven approaches, employing

expert systems and ML algorithms, have become prevalent for informed decision-making based on data. This study introduces an efficient self-care classification model integrating Principal Component Analysis (PCA) for feature extraction and DT for classification. PCA is applied to extract pivotal features, and DT is utilized to formulate the classification model. Through a comprehensive evaluation, inclusive of various metrics and comparison with existing models, our proposed model exhibits superior performance, achieving an accuracy of 94.29% in 10-fold cross-validation. Significantly, PCA-based feature extraction yields positive contributions, enhancing the model's performance with 1.7% improvement in average accuracy as compared to classifiers without PCA. The study's outcomes are anticipated to provide valuable insights for occupational therapists, illuminating the effectiveness of self-care classification and children's therapy.

In [25], Autism Spectrum Disorder (ASD) comprises a range of neurodevelopmental conditions without a cure, but early interventions can help alleviate its impact. We compiled ASD datasets spanning toddlers, children, adolescents, and adults, applying various feature transformation techniques such as log, Z-score, and sine functions. Employing different classification methods on these transformed datasets, we observed SVM excelling for toddlers, Adaboost for children, Gmboost for adolescents, and Adaboost for adults. The optimal feature transformations were found to be the sine function for toddlers and Z-score for children and adolescents. Subsequently, Z-score-transformed datasets underwent

feature selection to identify significant ASD risk factors for toddlers, children, adolescents, and adults. The outcomes suggest that, when appropriately optimized, ML methods can offer accurate predictions of ASD status, raising the potential for early-stage ASD detection.

In [26], Intellectual Disability (ID) is described as a developmental deficiency syndrome arising from congenital diseases or postnatal events. Timely and effective screening for this syndrome can significantly impact patient outcomes and improve their self-care abilities. Present screening methods typically rely on clinical interviews, demanding extensive involvement of medical professionals and related resources. This study introduces a new approach to ID screening by examining facial phenotypes and phonetic characteristics in young subjects. The geometric features of subjects' faces and phonetic features from interview videos are extracted. The craniofacial variability index (CVI) is then computed using geometric features to assess the risk of ID. Machine learning algorithms are utilized to create a method for additional ID screening based on facial and phonetic features. The proposed method, integrating three feature sets (geometric features, CVI features, and phonetic features), underwent evaluation, achieving an accuracy nearing 80%. The outcomes obtained with the three feature sets imply that the proposed method holds potential for future clinical application, pending ongoing refinements.

In Table 2, a comprehensive parametric analysis of existing techniques to classify self-care problems in children with disabilities has been presented.

Table II. Parametric Analysis of Existing Research Work to Classify Self-Care Problems in Children with Disabilities using Machine Learning Models.

Ref no.	Method Name	ML Classifier used	Dataset used	Dataset Availability	Performance metrics
[6]	Care2Vec: a hybrid autoencoder-based approach	ICF-CY, Decision trees, k-fold cross-validation, DNN	SCADI	Public	Accuracy: Mean CV: 84.29% ROC AUC: 95.45%
[7]	ANN, SVM, and RF based approach	ANN, SVM, Random Forest	SCADI	Public	Accuracy: 85.4%,
[8]	A predictive model named GA-XGBoost, merging genetic algorithms (GAs) with extreme gradient boosting (XGBoost)	XGBoost, GA	SCADI	Public	Accuracy: 98.57 % Precision: 79.92% Recall: 84.75% F1-score: 81.21%
[9]	Machine Learning Framework for Context-Aware Service Selection	KNN, SVM, RF, DT, LogR, SPS	QWS V2.0 and WS-DREAM	Public	Accuracy 85.15 %
[10]	Machine learning framework for feature extraction	Quantile Transformer (QT), Power, Transformer (PT), Normalizer, and Max Abs Scaler (MAS)	ASD datasets	Public	Accuracy: 97.95%
[11]	An expert system based on Probabilistic Neural Network (PNN) as the classifier and leverages the Genetic Algorithm (GA)	PNN, GA	ICF-CY dataset	Public	Accuracy: 94.28%
[12]	A predictive model based on DNN	DNN	SCADI	Public	Accuracy 87.14%

[13]	SVM based expert model	SVM, RF	SCADI	Public	Accuracy 97.14%
[14]	Partitioned Multifilter with Partial Swarm Optimization (PM PSO)	NB, MLP, C-4.5, Random Tree	SCADI	Public	Accuracy: NB: 81.42%, MLP: 80%, C 4.5: 80%, RT: 78.57%
[15]	ICF-CY based Predictive Model	RF, SVM, NB, Hoeffding Tree, LLWL	SCADI	Public	Accuracy: RF: 84.75%
[16]	A model to extract classification features for children with disabilities	J48, RT, PART algorithm	SCADI	Public	Accuracy: PART: 81.5%
[17]	A classification framework for identification of pathological disorders in children	RBF-SVM, DT using C4.5, KNN, RF, K*	SCADI	Public	Accuracy: RF: 84.29% DT, KNN: 81.43% RBF-SVM: 80% K*: 78.57%
[18]	A PCA based KNN Approach	ELM, KNN, SVM, ANN, RF, GB	SCADI	Public	Accuracy: PCA-KNN: 84.29%
[19]	A datadriven methodology based on machine learning in categorizing disabilities in children	Bayesian Network, 3-layer perceptron, JRip	SCADI	Public	Accuracy of Bayesian Net is higher
[20]	1-NN, Chi2, Relief, Synthetic Minority Oversampling Technique	Logistic Regression (LR), DT, RF, NB, KNN, SVM, , Neural Network Multilayer Perceptron (MLP), AdaBoost,	Large-scale ASD dataset	Private	Accuracy: DT: 97.86% RF: 82.97% NB: 80.02% KNN: 98.34% SVM: 71.05% LR: 81.99% AdaBoost: 99.95% Neural Net MLP: 99.25%
[21]	1. RIPPER-based toddler subset, 2. Correlation-based Feature Selection (CFS) and Boruta CFS intersect (BIC) method-based child subset 3. Boruta-based adolescent subset 4. CFS-based adult subset	SVM	Toddlers ASD datasets, ASD datasets of children, ASD datasets of adolescents, ASD datasets of adults	Public	Accuracy: 1. 97.82% 2. 99.61% 3. 95.87% 4. 96.82%
[22]	Smart Model Capable of Generating Fuzzy Rules	Artificial Neural Networks and Fuzzy Systems	Not Mentioned	Available on Request for Researchers	Promising results with better accuracy indexes than initial studies
[23]	CNN Models DNN Model (Classifier)	MobileNet, Xception, EfficientNetB0, EfficientNetB1, EfficientNetB2	ASD	Public	AUC: 96.63% Sensitivity: 88.46%
[24]	Self-Care Classification Model	PCA, DT	Not Available	Private	Accuracy: 94.29%
[25]	SVM, Adaboost, Gmboost Feature Transformations Selection	Log, Z-score, Sine; Z-score	ASD	Public	Accuracy: 92%
[26]	Classification Techniques based on Feature Transformation And Feature Selection	SVM, Adaboost, Gmboost Log, Z-score, Sine	ASD	Public	Accuracy: 80%

B. Discussion and key findings: The findings collectively highlight the diversity of approaches and the significant potential of machine learning techniques in identifying self-care problems in disabled children across various datasets and conditions. The breakdown of the

key findings from the studied research works is as follows;

Model Diversity and Complexity:

1. **Hybrid Approaches:** Several studies combined different methodologies such as hybrid autoencoder-based solutions [6], merging genetic algorithms with boosting techniques [8], and fuzzy rule generation [22], demonstrating the versatility of hybrid models in achieving high accuracies.

2. **Feature Selection and Extraction:** Feature selection played a crucial role in many studies, enhancing predictive accuracies. Techniques like genetic algorithms ([11]), PCA ([24]), and various transformation methods ([10], [25], [26]) improved model performance.

Accuracy and Performance:

1. **High Accuracy Rates:** Many models achieved impressive accuracies ranging from mid-80s to near-perfect scores, validating their efficacy in identifying self-care issues in disabled children ([8], [10], [13], [21], [23], [24]).

2. **Algorithm Selection Impact:** The choice of algorithms significantly influenced accuracy. For instance, SVM and Random Forest frequently showed competitive performance, while boosting techniques like AdaBoost proved highly accurate.

Dataset Utilization and Availability:

1. **Dataset Influence:** Some studies utilized publicly available datasets, like SCADI and ICF-CY, showing their applicability in research. However, the private nature of certain datasets limited accessibility and assessment in specific studies.

2. **Dataset Availability:** The significance of publicly available datasets became evident in studies utilizing them, enabling comparisons, benchmarking and fostering collaboration in the research community.

Model Interpretability and Utility:

1. **Interpretability:** Some models, such as those incorporating fuzzy logic or using decision trees provided more interpretable insights, facilitating better understanding and application of results in clinical settings.

2. **Clinical Relevance:** The research works strived to create models useful for therapists and medical professionals by focusing on clinically relevant features and classification rules [11], [16], [20], [23].

Overall, these findings highlight the promising role of machine learning in identifying self-care problems in disabled children. The wide variety of approaches reflects the multifaceted nature of the problem and the need for

adaptable, accurate, and interpretable models in clinical decision-making and therapy planning.

C. Future directions

1. Imbalanced datasets affected model performance in some research works. So, there is a need to work on the techniques to balance and fine tune dataset to get accurate and improved classification rates.

2. Future research endeavors should focus on the ongoing refinement of techniques, integration of additional features, and comprehensive exploration of ensemble methods. These efforts can significantly augment the performance and resilience of the model, paving the way for enhanced capabilities and reliability in varied applications.

Conclusion: The domain of pediatric healthcare concerning self-care challenges in disabled children is undergoing a transformative evolution, driven by the integration of machine learning (ML) methodologies. This paper explores the growing field of ML applications in identifying and addressing these crucial issues. This comprehensive review aimed to bridge the existing gap by providing a panoramic view of ML-based approaches dedicated to resolving self-care problems in disabled children. Physical and motor disabilities pose challenging barriers to personal activities, demanding expert intervention and thorough analysis. The conventional methods for diagnosing and addressing these challenges often demand significant time and expertise from occupational therapists, necessitating innovation. Leveraging the International Classification of Functioning, Disability, and Health for Children and Youth (ICF-CY), machine learning emerges as a promising tool for classifying self-care problems among these children. The array of methodologies illustrated in this review highlights the diversity and potential of ML techniques. Hybrid models incorporating autoencoders, genetic algorithms and fuzzy logic among others, showed remarkable accuracies in classifying self-care problems. Feature selection and extraction techniques significantly improved model performance, enhancing interpretability and relevance in clinical settings. Accurate classification of self-care issues holds significant implications for disabled children's quality of life and autonomy. The integration of ML technologies has the potential to revolutionize identification and intervention strategies, offering tailored solutions to enhance well-being and independence. While these advancements are promising, challenges persist, notably in dataset availability, imbalance and the need for continued refinement of techniques. Bridging the gap between research and clinical application remains essential for utilizing ML's full potential in pediatric healthcare. Continued collaboration and refinement will be instrumental in

realizing the transformative promise of machine learning for the benefit of disabled children.

REFERENCES

- [1] S. Lindsay, S. Kingsnorth, C. Mcdougall, and H. Keating, "A systematic review of self-management interventions for children and youth with physical disabilities," *Disabil. Rehabil.*, vol. 36, no. 4, pp. 276-288, Feb. 2014.
- [2] D. Edwards, J. Noyes, L. Lowes, L. Haf Spencer, and J. W. Gregory, "An ongoing struggle: a mixed-method systematic review of interventions, barriers and facilitators to achieving optimal self-care by children and young people with type 1 diabetes in educational settings," *BMC Pediatrics*, vol. 14, pp. 1-27, 2014.
- [3] I. Dall'Oglio, G. Gasperini, C. Carlin, V. Biagioli, O. Gawronski, G. Spitaletta, et al., "Self-care in pediatric patients with chronic conditions: a systematic review of theoretical models," *Int. J. Environ. Res. Public Health*, vol. 18, no. 7, pp. 3513, 2021.
- [4] R. Town, D. Hayes, A. March, P. Fonagy, and E. Stapley, "Self-management, self-care, and self-help in adolescents with emotional problems: a scoping review," *Eur. Child Adolesc. Psychiatry*, vol. 1, pp. 1-28, 2023.
- [5] M. E. Minissi, I. A. ChicchiGiglioli, F. Mantovani, and M. Alcaniz Raya, "Assessment of the autism spectrum disorder based on machine learning and social visual attention: A systematic review," *J. Autism Dev. Disord.*, vol. 52, no. 5, pp. 2187-2202, 2022.
- [6] S. Putatunda, "Care2Vec: a hybrid autoencoder-based approach for the classification of self-care problems in physically disabled children," *Neural Comput. Appl.*, vol. 32, pp. 17669-17680, 2020.
- [7] T. Le and S. W. Baik, "A robust framework for self-care problem identification for children with disability," *Symmetry*, vol. 11, no. 1, pp. 89, 2019.
- [8] M. Syafrudin, G. Alfian, N. L. Fitriyani, M. Anshari, T. Hadibarata, A. Fatwanto, and J. Rhee, "A self-care prediction model for children with disability based on genetic algorithm and extreme gradient boosting," *Mathematics*, vol. 8, no. 9, pp. 1590, 2020.
- [9] A. Namoun, A. A. Abi Sen, A. Tufail, A. Alshantqi, W. Nawaz, and O. BenRhouma, "A two-phase machine learning framework for context-aware service selection to empower people with disabilities," *Sensors*, vol. 22, no. 14, pp. 5142, 2022.
- [10] S. M. Hasan, M. P. Uddin, M. Al Mamun, M. I. Sharif, A. Ulhaq, and G. Krishnamoorthy, "A Machine Learning Framework for Early-Stage Detection of Autism Spectrum Disorders," *IEEE Access*, vol. 11, pp. 15038-15057, 2022.
- [11] S. F. Bushehr and M. S. Zarchi, "An expert model for self-care problems classification using probabilistic neural network and feature selection approach," *Appl. Soft Comput.*, vol. 82, pp. 105545, 2019.
- [12] A. R. Karaci, "Self-Care Problems Classification of Children with Physical and Motor Disability by Deep Neural Networks," *Politeknik Dergisi*, vol. 23, no. 2, pp. 333-341, 2020. doi:10.2339/politeknik.522641
- [13] Vijayalakshmi, Saira, Banu, and Kathiroli, Panimalar, "Expert System based on Feature Selection for Classification of Self-Care Problems in Children and Youth People," *Grenze International Journal of Engineering and Technology*, 2022.
- [14] M. Sharma, "Categorization of self-care problem for children with disabilities using partial swarm optimization approach," *Int. J. Inf. Technol.*, pp. 1-9, 2020.
- [15] A. Choudhury and C. Greene, "Classification of Functioning, Disability, and Health for Children and Youth: ICF-CY Self Care (SCADI Dataset) Using Predictive Analytics," *arXiv preprint arXiv:1901.00756*, 2018.
- [16] M. Zrodowska and A. Dardzińska-Głębocka, "Classification and action rules in identification and self-care assessment problems," *Technol. Health Care*, vol. 30, no. 1, pp. 257-269, 2022.
- [17] S. Beborrtta, M. Panda, and S. Panda, "Classification of pathological disorders in children using random forest algorithm," in *2020 International Conference on Emerging Trends in Information Technology and Engineering (ic-ETITE)*, pp. 1-6, IEEE, Feb. 2020.
- [18] B. Islam, N. M. Ashafuddula, and F. Mahmud, "A machine learning approach to detect self-care problems of children with physical and motor disability," in *2018 21st International Conference of Computer and Information Technology (ICCIT)*, pp. 1-4, IEEE, Dec. 2018.
- [19] S. S. Chawathe, "Classifying self-care activities of children and youths with disabilities," in *2018 9th IEEE Annual Ubiquitous Computing, Electronics & Mobile Communication Conference (UEMCON)*, pp. 922-928, IEEE, Nov. 2018.
- [20] A. S. Albahri, R. A. Hamid, A. A. Zaidan, and O. S. Albahri, "Early automated prediction model for the diagnosis and detection of children with autism spectrum disorders based on effective

- sociodemographic and family characteristic features," *Neural Comput. Appl.*, vol. 35, no. 1, pp. 921-947, 2023.
- [21] M. Bala, M. H. Ali, M. S. Satu, K. F. Hasan, and M. A. Moni, "Efficient machine learning models for early stage detection of autism spectrum disorder," *Algorithms*, vol. 15, no. 5, pp. 166, 2022.
- [22] P. V. Souza et al., "Using hybrid systems in the construction of expert systems in the identification of cognitive and motor problems in children and young people," in 2019 IEEE international conference on fuzzy systems (FUZZ-IEEE), pp. 1-6, IEEE, June 2019.
- [23] K. K. Mujeeb Rahman and M. M. Subashini, "Identification of autism in children using static facial features and deep neural networks," *Brain Sciences*, vol. 12, no. 1, pp. 94, 2022.
- [24] M. Syafrudin et al., "Improving Efficiency of Self-care Classification Using PCA and Decision Tree Algorithm," in 2020 International Conference on Decision Aid Sciences and Application (DASA), pp. 224-227, IEEE, Nov. 2020.
- [25] T. Akter et al., "Machine learning-based models for early stage detection of autism spectrum disorders," *IEEE Access*, vol. 7, pp. 166509-166527, 2019.
- [26] Y. Chen et al., "Screening Children's Intellectual Disabilities with Phonetic Features, Facial Phenotype and Craniofacial Variability Index," *Brain Sciences*, vol. 13, no. 1, pp. 155, 2023.