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Asthma control and academic performance of school-aged children with asthma

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Abstract: *Background:* A number of factors are thought to influence the academic performance of children with asthma (Subjects) and asthma control is one. Reports on the influence/impact of asthma control on the academic performance of children with asthma are limited and the independent contribution of asthma status, if any, to academic performance of children with asthma has been poorly explored.
Aims: To determine the influence of asthma control on the academic performance of children with asthma in Enugu, Nigeria.
Methods: Children with Asthma (Subjects) aged 5–11 years were recruited consecutively at the weekly asthma clinic of the University of Nigeria Teaching Hospital (UNTH) Enugu, Nigeria. Level of asthma control was ascertained using the Childhood Asthma Control Test (C-ACT) tool. The IQ of the subjects was calculated using the validated Ziler criteria and the table of Draw –A-person Quotient (DAPQ) by Ebigbo and Izuora. The total number of days of school absence for the academic session was obtained from the class attendance register. Academic performance was assessed using the average of the overall scores in the three term examinations of the academic session.
Result: The prevalence of high school absence among subjects with poor asthma control was higher compared to those with good asthma control and this difference was statistically significant (x^2 = 14.67; d.f = 1; $p < 0.001$). The difference between the median (range) overall academic score of children with poor asthma control (79.96% (36.00% - 93.57%)) and that of those with good control (78.11% (37% - 99.57%)) was not statistically significant (U= 1235, $p = 0.486$). However on multivariate analysis, good asthma control had a significant positive effect on academic performance (= 1.080, $p = 0.003$).
Conclusion: Asthma control had a significant positive effect on academic performance of school children with asthma.

Keywords: Academic performance, Asthma, Asthma control, Children, Primary School

Introduction

Asthma is one of the most common chronic illnesses among children, affecting over six million children globally.[1] In Nigeria, studies in among children have reported prevalence of 7.2 and 7.1 % in Ibadan and Enugu respectively.[2,3] Children with asthma, similar to children with other chronic illnesses, are at the intersect of the health and education systems and are expected to compete with non-asthmatic counterparts in the same classroom under the same learning conditions.[4] When asthma is poorly controlled, children are said to be at greater risk for decrements in other areas of functioning which may include their academic performance. Studies on the effect of asthma status on academic performance are few and to date, the extent to which asthma status affects children's academic performance as well as the exact way in which poor asthma control may cause poor academic performance is not well documented. Increased school absenteeism, impact of nocturnal asthma on these children and psychosocial impact of asthma are some of the suggestions that have been put forward.[5-8]
Asthma has been reported to be one of the most common causes of school absenteeism among chronic health conditions in childhood and increased absenteeism by school children with asthma has been well documented.[9-14] Poorly controlled or persistent asthma could lead to a significant number of days of absence from school and this can affect their academic performance.[5,6,15] Nocturnal asthma can affect children's sleep quality and duration which can interfere with attention in school and impact the quality of school work.[7]

While Gonzales-Macias[16] reported a weak association between well-controlled asthma and good classroom performance, Moonie et al[15] noted that persistent asthma negatively affects academic performance. Although Gonzales-Macias[16] used asthma control and Moonie et al[15] assessed asthma severity, their findings were similar. However Nduagubam et al[14] in Nigeria reported that there was no difference in the overall academic performance of children with asthma when compared to children without. However while some studies[15, 16] suggested that poor asthma status caused poor academic performance through increase in school absence; Koinis-Mitchell in a study in 2013 opined their poor academic performance to poor sleep quality among children with nocturnal or poorly controlled asthma.[17] More recently still, another study by suggested that asthma may impact children's academic performance and attributed this impact factors which include the increased school absence and poor sleep quality observed in children with poor asthma control.[18]

No studies to the best of my knowledge have been done on the relationship between asthma status (level of asthma control) and academic performance among children with asthma in Nigeria. This study therefore looked at the effect of asthma control on the academic performance of primary school children with asthma in Enugu State Nigeria.

Materials and Methods
Study Design

This was a cross-sectional, hospital- and school-based descriptive study.

Study Area/Site

The study was carried out at the University of Nigeria Teaching Hospital (UNTH), Ituku/Ozalla, Enugu State. The Subjects were children with asthma attending the Paediatric Asthma clinic of the hospital. The clinic holds every Tuesday morning with four doctors and three nurses attending to an average of 25 persons, including five new cases per week. The paediatric asthma clinic from the hospital records attends to an average of 304 patients per year, of which 148 patients (48.7%) are children aged 5-11 years.

Sample Size

The minimum sample size for the study was determining using the formula for sample size calculation
that when the study population is >10,000:

$$n = \frac{z^2 p q}{d^2}$$

where n = sample size

z = z score at 95% confidence limit (1.96)

p = estimated prevalence when prevalence of poor academic performance in children with asthma is not known = 0.50

q = 1.0 – p = 0.5

d = degree of accuracy at 95% confidence limit (0.05)

$$n = \frac{1.96^2 \times 0.5 \times 0.5}{0.05^2} = 384$$

and when study population is <10,000,

$$nf = \frac{n}{1 + \frac{n}{N}}$$

where nf = final sample size

n = sample size when study population is >10,000

N = study population size (number of school-aged asthmatics attending the Asthma Clinic) = 148

$$nf = \frac{384}{1 + \frac{384}{148}} = 107$$

Sample size allowing for 10% attrition = 120

The total number of children with a diagnosis of asthma enrolled into the study was 120.

Inclusion Criteria

1. Children aged 5-11 years, attending primary school in Enugu metropolis.
2. Asthma diagnosed by a doctor.[19,20]
3. Attendance in the same school for at least one session before study enrolment.
4. Attendance at the asthma clinic for at least 12months.
5. Consent for the study given by care-giver.

Exclusion Criteria

1. Out of school children.
2. Age less than five years or more than eleven years of.
3. Children with other chronic diseases like sickle cell disease, diabetes mellitus, tuberculosis, congenital heart diseases or with history of neurologic illness like seizure disorders and cerebral palsy. These were excluded because the disorders are known to affect academic performance, hence the independent effect of asthma may be difficult to determine.[21]
4. Children attending school outside Enugu metropolis
5. Attendance of the present primary school for less than one session before enrolment
6. Refusal of consent by care-giver.
7. Asthmatic children with incomplete data, since some of the information were obtained from the case notes.

Primary school-aged children with asthma attending the weekly asthma clinic of the University of Nigeria Teaching Hospital (UNTH), Enugu were the study population. Consecutive children with asthma aged 5–11 years who have been in primary school for one academic session during the study period (September 2012 – August 2013) were recruited. Before enrollment, in order to ascertain eligibility, necessary data (including age, sex, school, class, medical history, occupation and education of both parents) were obtained from the accompanying parent/caregiver of the asthmatic child and the child subsequently assessed clinically for chronic and debilitating medical conditions such as heart disease, seizure

disorders and cerebral palsy that are known to affect academic performance independently.[21] One hundred and twenty children with asthma who satisfied the inclusion criteria were recruited after informed consent were obtained from their parents/caregivers. Criteria for inclusion in the study were children with asthma diagnosis made by a doctor, aged 5 - 11 years attending primary school within Enugu metropolis. The child selected must have attended the same school for at least one academic session before enrolment and have been attending asthma clinic of UNTH Ituku/Ozalla for at least 12 months.

At the clinic, children who met the inclusion criteria were enrolled consecutively till the sample size was reached while those excluded were scheduled for consultation. The level of asthma control was ascertained using the Childhood Asthma Control Test (C-ACT™).[22] This C-ACT™ tool for children 4 to 11 years is made up of seven questions with a total score of 27 as the highest score obtainable. Each child, as much as possible, was allowed to answer the first four questions unaided while the care-giver answered the remaining three. A score of 19 and below signifies poor control while scores above 19 (20-27) indicate good control.[23,24]

There was no validated academic achievement measure in Nigeria; hence this study, similar to earlier related studies,[25,26] employed the use of school examination report. At school, the average overall score in percentage for each child in each of the three term examinations for 2012/2013 academic session was calculated as a measure of the overall score academic performance of the child. The average of the scores for the academic session for each of the children in each of the four key subjects (English, Mathematics, Social Studies and Sciences) expressed in percentage, was used as a measure of their specific academic performance. These represented the academic performances (Overall and specific) and were further graded as high (75%), average (50 – 74%) and low (< 50%). Those with low scores were considered as having poor academic performance. This measure has been used previously for the assessment of academic performance of school children.[25,26,27,28]

However, varying standards between individual teachers may affect this measurement approach.
From the class attendance register, each child's total number of days of absence for the entire academic year was obtained. School absence was classified as described by Weitzman and colleagues.[29] High school absence was taken as >12 school day's absence and low school absence as 1 – 12 school days' absence.[29]
Each child was given a sheet of paper and pencil and left alone with as much time as they needed with the instruction to draw a person.[30,31] The Intelligence Quotient (IQ) of the subjects and controls were calculated using the validated Ziler criteria[30] and the table of Draw-A-Person Quotient (DAPQ) by Ebigbo and Izuora.[30]
Socio-economic status of both children with asthma and those without was determined using the occupation and educational attainment of their parents as proposed by

Oyedeji.[32] Class I represented the highest social class and class V the lowest. Each parent was scored separately by finding the average score of the two factors (occupation and educational level). The mean of the scores for the father and mother approximated to the nearest whole number was chosen as the social class of the child.

Health Research Ethics Committee of University of Nigeria Teaching Hospital (UNTH), Enugu approved the study and the Enugu State Ministry of Education gave clearance before the study was commenced. Information obtained was recorded in a proforma. Means of academic performance and socio-economic class that were not normally distributed were compared using the Mann-Whitney U test. The significance of association between categorical variables was determined using chi-square. Correlation analysis was done using Pearson's correlation coefficient. Multiple linear regression analysis was used to assess for predictors of academic performance in children with asthma. The level of significance was taken as $p < 0.05$.

Results

A total of 120 children with asthma were enrolled in the study. Eighty-one (67.5%) were males and 39 (32.5%) females (male: female ratio 2.1:1). The age range was 5 to 11 years while the mean age ± standard deviation (SD) was 8.20 ± 1.92years. Seventy-five percent (75%) of the children in this study were from the higher socio-economic classes I and II.
Forty eight children with asthma (40%) had a history of hospital visits (emergency room visits/ hospital admission) which ranged from 1 to 5 days within the one year period under consideration. Thirty-five percent of all the subjects had acute asthma attacks as the only reason for hospital admission during the period. Majority (77.8%) of the asthmatics who had hospital admissions had an average hospital stay of one to three days before discharge. High school absence was significantly associated with hospital visits ($x^2 = 16.08$; d.f = 1; $p < 0.001$).
All the children in this study had IQs within the normal range for age and sex. The mean ± SD Draw A person Quotient (DAPQ) scores for children with poor asthma control was 122.91±18.54 and children with good control 123.41± 22.54. The difference was not statistically significant ($p = 0.215$).
Thirty-three (91.7%) out of the 36 subjects with high school absence had poor asthma control while the remaining 3 (8.3%) had good asthma control. The prevalence of high school absence among subjects with poor asthma was higher compared to those with good asthma control and this difference was highly statistically significant (Table 1).

Table 1: Comparison of asthma control and school absence amongst subjects

| No. of days absent | Asthma control | | |
	Poor n (%)	Good n (%)	Total n (%)
Low absence	36 (54.5)	30 (45.5)	66 (100.0)
High absence	33 (91.7)	3 (8.3)	36 (100.0)
Total	69 (67.6)	33 (32.4)	102 (100.0)

$X^2 = 14.67$; d.f = 1; $p < 0.001$

The median (range) overall academic score for children with poor asthma control was 79.96% (36.00% - 93.57%) while that of those with good control was 78.11% (37% - 99.57%). The difference in the median overall academic score for children with poor asthma control and good control was not statistically significant ($U = 1235$, $p = 0.486$).

Out of the 120 children with asthma studied, 30 (25%) had poor asthma control and academic performance of six of them (5%) was poor. There was no significant relationship between poor asthma control and academic performance (Table 2).

Table 2: Comparison of academic performance and asthma control of subjects

| Asthma control | Academic Performance | | | |
	Poor n (%)	Average n (%)	Good n (%)	Total n (%)
Good	3 (3.3)	39 (43.3)	48 (53.3)	90 (100.0)
Poor	3 (10.0)	9 (30.0)	18 (60.0)	30 (100.0)
Total	6 (5.0)	48 (40.0)	66 (55.0)	120 (100.0)

$X^2 = 3.18$; d.f = 2; $p = 0.204$

However on the multiple regression, the coefficient of determination in the subjects ($R^2 = 0.311$), indicate that less than half the variation in academic performance is explained by the model. Asthma control had a significant positive effect on academic performance ($= 1.080$, $p = 0.003$) but not school absence ($= 0.148$, $p = 0.394$) (Table 3).

Table 3: Multiple linear regression result of predictors of academic performance among children with asthma

Variables		p- value
Age	-3.776	<0.001
Socio-economic class	1.836	0.183
DAPQ	0.034	0.579
Asthma control	1.080	0.003
No. of days absent	0.148	0.394

$R = 0.557$; $R^2 = 0.311$

Children with poor asthma control had significantly higher mean scores at 5years ($p = 0.002$) and lower median overall academic scores at ages 9 ($P = 0.032$) and 11years ($p = 0.015$). Comparisons could not be made at 6 and 10 years of age because none of the children at these ages had poor control. There was a statistically significant negative correlation (Pearson's) between age and median overall score in subjects with poor ($r = -0.839$, $p < 0.001$) and good ($r = -0.341$, $p = 0.001$) asthma control (Table 4).

Table 4: Age specific comparison of academic performance and asthma control of subjects

| Age (years) | Asthma control | | Mann-Whitney U | P -value |
	Poor (n = 30) Median (Mean rank)	Good (n = 90) Median (Mean rank)		
5	89.12 (15.00)	78.11 (6.75)	3.00	0.002
6	NA	99.57 (2.00)	NA	NA
7	82.28 (6.50)	92.84 (11.00)	18.00	0.089
8	83.94 (12.42)	86.62 (16.27)	53.50	0.336
9	71.28 (7.17)	73.96 (14.28)	22.00	0.032
10	NA	91.00 (2.00)	NA	NA
11	49.39 (6.50)	68.31 (14.50)	18.00	0.015

NA = Not Available

Discussion

In this study asthma control was found to be a predictor of academic performance as children with good asthma control had better academic performance compared to children with poor asthma control in the presence of other factors (age, socio-economic class, school absence and IQ). The larger proportion of subjects with good asthma control compared to those with poor asthma control in this study may have influenced this result. Additionally selection of the subjects for this study was from the asthma clinic where these children were being followed up regularly and therefore the study population had more children with good asthma control. However, the effect of asthma control on academic performance noted in this study is in alignment with some earlier studies.[15,16,17,18] Although Gonzales-Macias[16] used asthma control and Moonie et al[15] assessed asthma severity, their findings were similar. Moreover, Koinis-Mitchell et al in their study used both asthma severity and level of asthma control and their report suggested that asthma control has significant impact on academic performance of children with asthma

Although increased school absence was suggested as the route via which poor asthma control caused poor academic performance among children with asthma;[15,16] the relationship between school absence and academic performance in children with asthma is still being researched.[9,10,11,15,16,18,33] Children with persistent asthma experience recurring episodes of absenteeism, which may contribute to decreased school performance.[33] Similarly in this study, the prevalence of high school absence among subjects with poor asthma was significantly higher compared to those with good asthma control. The reason for increased school absence among the subjects with poor asthma control compared to those with good asthma control is unknown but could probably be due to the frequent hospital visits by these children as was found in this study which could take them out of school more than those with good asthma control. However despite the increased school absence among asthmatics with poor asthma control, it appeared not to affect their academic performance significantly when compared to those with good asthma control. The fewer number of children with poor asthma control compared to those with good asthma control in this study may have masked

their effect. However on multivariate analysis, putting other factors of age, Socio-Economic Status, number of days absent from school, DAPQ along with level of asthma control, asthma control and age were found to good predictor of academic performance. This is in alignment with some earlier studies[15,16,18]. However the exact route via which asthma control affects academic performance in these children was not further elucidated in this study. Apart from increased school absence, some earlier works have suggested that poor sleep quality in these children[17] and psychological impact[8,34] of poor asthma control as the possible route. Further studies on the influence of asthma control on academic performance are therefore needed.

The mean DAPQ scores for children with good asthma control and that of children with poor asthma control in this study were comparable. Similar reports on IQ have been reported among children with asthma and those with SCA.[25,34,35] This finding of similarity in mean DAPQ of both children with poor asthma control and those with good asthma control probably means the intelligence of the children in both groups was comparable irrespective of the level of control of asthma hence asthma or its level of control may not directly affect intelligence.

Regardless of the level of asthma control (good or poor); age was observed to be a predictor of academic performance. This probably means age may influence academic performance irrespective of the level of asthma control. Similar trend of decline in IQ with increasing age was also noted among the subjects. Such trend in decline in IQ with age has been reported in children with other disease conditions such as Childhood diabetes[36], obesity[37] and SCA[16]. This probably buttresses the fact that IQ is a major predictor of academic performance. However although the trend of decline in mean DAPQ was observed in both groups (good and poor asthma control; the decline appeared more obvious with increasing age among children with poor asthma control. However although there was a decline in academic performance in both groups; the trend in the decline in academic performance with increasing age among the children with poor asthma control appeared worse. The difference is probably due to their poor asthma control and may reflect the challenges of school absence, poor sleep quality faced by these children coupled with higher mental demands in advancing class at higher ages of 9 and 11 compared to 5 years. Further studies including studies on academic performance of children with asthma above primary school age may offer more insight on this trend.

Conclusion

Children with good asthma control had better academic performance compared to children with poor asthma control.

Recommendation

Good asthma control therefore is essential for a child with asthma to attain optimal academic potential. Parents of children diagnosed with asthma should be encouraged to attend asthma clinic run by specialists who will ensure attainment and proper monitoring of their asthma control.

Acknowledgement

References

1. Masoli M, Fabian D, Holt S, Beasly R. The global burden of asthma: Executive summary of the GINA Dissemination Committee report. *Allergy. 2004; 59: 469-478.*

2. Falade AG, Olawuyi F, Osinusi K, Onadeko BO. Prevalence and severity of symptoms of asthma, allergic rhino-conjunctivitis and atopic eczema in secondary school children in Ibadan, Nigeria. *East Afr Med J 1998; 75: 695-698.*

3. Okoromah NC. A study of bronchial asthma among primary school children in Enugu urban area. Part 2 Fellowship Dissertation, National Post-graduate Medical College of Nigeria 1995.

4. Bateman ED, Hurd SS, Barnes PJ, Bousquet J, Drazen JM, FitzGerald M, *et al.* Global strategy for asthma management and prevention: GINA executive summary. *Eur Respir J 2008; 31: 143-178.*

5. Basch, C.E. Asthma and the achievement gap among urban minority youth. *J School Health. 2011; 81: 606–613.*

6. Reynolds, K.C., Boergers, J., Kopel, S.J., and Koinis-Mitchell, D. Multiple comorbid conditions, sleep quality and duration, and academic performance in urban children with asthma. *J Pediatr Psychol. 2018; 43: 943–954.*

7. Koinis-Mitchell, D., Kopel, S.J., Seifer, R. et al. Asthma-related lung function, sleep quality, and sleep duration in urban children. *Sleep Health. 2017; 3: 148–156.*

8. Swadi H. Psychiatric morbidity in a community sample of Arab children with asthma. *J Trop Pediatr 2001; 47(2): 106-7.*

9. Taras H, Potts–Datena W. Chronic health conditions and students performance at school. *J Sch Health .2005; 75: 255 – 266.*

10. Krenitsky- Korn S. High school students with asthma: attitudes about school health, absenteeism, and its impact on academic achievement. *Paediatr Nurs.2011; 37:61-68.*

11. Gutstadt LB, Gillette JW, Mrazek DA, Fukuhara JT, La Brecque JF, Strunk RC. Determinants of school performance in children with chronic asthma. *Am J Dis Child 1989; 143:471–475.*

12. Bender BG. Are asthmatic children educationally handicapped? *Sch Psychol 1995;Quart.10: 274-291.*

13. Baxter SD, Rover JA, Hardin JW, Guinn CH, Delvin CM. The relationship of school absenteeism with BMI, academic achievement and socio-economic status among fourth- grade children. *J Sch Health 2011; 81:417-423.*

14. Nduagubam OC, Oguonu TA, Ojinnaka NC, Ibekwe RC. Impact of school absence on academic performance of school children with asthma in Enugu, Nigeria. *J Exp esearch. 2017. 5 (2):1-7.*

15. Moonie S, Sterling DA, Figgs LW, Castro M. The relationship between school absence, academic performance, and asthma status. *J Sch Health 2008; 78: 140-148.*

16. Gonzales-Macias LD. Consequences of asthma in elementary students. ProQuest *LLC*, Ph.D. Dissertation, Arizona State University. 2009.

17. Koinis-Mitchell D. Asthma symptoms impair sleep quality and school performance in children. Science Daily, Brown University. 2013.

18. Koinis-Mitchell D, Kopel SJ, Farrow ML, McQuaid EL, Nassau JH. *Asthma and academic performance in urban children. 2019.122 (5):471–477].*

19. Dolan CM, Frasher KE, Bleecher ER. Design and baseline characteristics of the epidemiology and natural history of asthma: outcomes and treatment regimens (TENOR) study. *Ann allergy Immunol 2004; 92: 32-39.*

20. Patel PH, Welsh C, Foggs MB. Improved asthma outcomes using a coordinated care approach in a large medical group. *Dis Manag 2004; 7: 102 -111.*

21. Perrin JM. Chronic illness in Children In: Kliegman RM, Arvin AM (Eds), Nelson's textbook of Paediatrics, 15th Ed. *W.B Saunders Co 1996; 124-127.*

22. Nathan RA, Sorkness CA, Kosinki M, Schat M, Li JT, Marcus P et al. Development of the asthma control test- A survey for assessing asthma control. *J Allergy Clin Immunol. 2004; 113: 59-65.*

23. Rimington LD, Davies DH, Lowe D, Person MG. Relationship between anxiety, depression and morbidity in adult asthma patients. *Thorax. 2001; 56: 266-271.*

24. Schatz M, Sorkness CA, Li JT, Marcus P, Murray JJ, Nathan RA, *et al.* Asthma Control Test reliability, validity and responsiveness in patients not previously followed by asthma specialist. *J Allergy Clin Immunol. 2006; 117: 549-556.*

25. Ezenwosu O.U, Emodi I.J, Ikefuna A.N, Chukwu B.F, Osuorah C.O. Determinants of academic performance in children with sickle cell anemia. *BMC Paediatr. 2013, 13: 189-197.*

26. Ibekwe RC, Ojinnaka NC, Iloeje SO. Academic performance of school children with epilepsy. *J Coll Med 2008; 13: 18-22.*

27. Akpan MU, Ojinnaka NC, Ekanem EE. Academic performance of school children with behavioural disorders in Uyo, Nigeria. *Afr Health Sci 2010; 10: 154 – 158.*

28. Ogunfowora OB, Olanrewaju DM, Akenzua GI. A comparative study of academic achievement of children with sickle cell anemia. *J Natl Med Assoc 2005; 97: 405-408.*

29. Weitzman M, Klerman LV, Lamb G, Menary J, Alpert JJ. School absence: a problem for the Paediatrician. *Pediatrics 1982; 69: 739-746.*

30. Ebigbo PO, Izuora GI. Draw a Person Test – Standardization, validation and guidelines for use in Nigeria. *Enugu: Chuka Printing Company Ltd. 1981; 7-32.*

31. William TO, Fall A, Eaves RC, Woods-Groves S. The reliability of scores for the Draw-A-Person intellectual ability test for children, adolescents and adults. *J Psyco-educ Assess. 2006; 24: 137-144.*

32. Oyedeji GA. Socio-economic and cultural background of hospitalized children in Ilesha. *Nig J Paediatr 1985; 12: 111-117.*

33. Silverstein MD, Mair JE, Katusic SK, Wollan PC, O'connell EJ, Yunginger JW. School attendance and school performance: a population-based study of children with asthma. *J Pediatr.2001; 139: 278-283.*

34. Javad G, Ali A, Masume J. IQ scores of children with moderate asthma: A comparison with healthy children. *Oman Med J. 2014; 29: 71-74.*

35. Daramola OO, Ayoola OO, Ogunbiyi AO. The comparison of intelligience quotient of atopic and non-atopic children in Ibadan Nigeria. *Ind J Dermatol 2010; 55: 221-224.*

36. Lin A, Northam EA, Werther GA, Cameron FJ. Risk factors for decline in IQ in youth with type I Diabetes Mellitus over the 12 years from diagnosis and illness onset. *Diabetes Care. 2014:14:1385.*

37. Belsky DW, CAspi A, Goldman-Mellor S, Meier MH, Ramrakha S, Poulton R, Moffitt TE. Is obesity associated with a decline in intelligence quotient during the first half of the life course? *Am, J, Epidemiol. 2013;10:1093.*