

Volumetric Changes in the Olfactory Bulb Depend on Body Mass Index

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Background/Objective:

Energy balance is preserved through the exchange between body weight and adipose tissue across the multi-faceted complex network that is composed of the sensorial, metabolic, and neuro-endocrine circuits. The olfactory control of energy homeostasis is maintained through central structures that include the hypothalamic-pituitary axis, together with the interplay between the olfactory bulb (OB) and adipose tissue. Although the interaction of the body mass index (BMI) with olfactory functions has been studied extensively, there is no clear information regarding its relationship with OB volume (OBV). This study focuses on the relationship between OBV and BMI.

Method:

The selected children (n=195) were categorized according to their BMI percentiles with the groups being broken down into normal weight (n=89), overweight (n=31), children with obesity (n=32) and children with severe obesity (n=43). The total brain volume (TBV)-corrected OBV were calculated using magnetic resonance imaging (MRI).

Results:

The mean of the OBV was higher in the children with a high body mass index (BMI) than in healthy group. The OBV increased in the overweight and children with obesity groups (43.76 ± 9.50 - 49.29 ± 8.61 mm³) but decreased in children with severe obesity (38.23 ± 11.52 mm³). In overweight and children with the obesity groups, a weak but positive correlation between the BMI and OBV was detected ($r_{31}=0.275$ - $r_{32}=0.377$), while in the children with severe obesity, a moderate negative correlation was detected ($r_{43} = -0.445$).

Table 2: Comparison of anthropometric, volumetric and metabolic variables between children with obesity groups

	Children with overweight (n=31)	Children with Obesity (n=32)	Children with Severely Obesity (n=43)	KW test p*	Multiple comparison		
					Children with overweight vs Children with obesity	Children with overweight vs Children with severely obesity	Children with obesity vs severely obese
Age (year)	11.01±1.78	11.23±2.28	11.13±2.44	0.654	0.473	0.512	0.253
Boy/Girl (n)	14/17	15/17	22/21	0.232	0.566	0.078	0.098
S (m ²)	1.43±0.21	1.65±0.25	1.76±0.26	<0.001	0.021	<0.001	0.041
Height (cm)	146.82±13.54	153.36±14.86	151.05±13.21	<0.001	0.012	0.042	0.002
Weight (kg)	49.35±11.23	64.37±15.44	73.53±11.45	<0.001	0.004	<0.001	<0.001
BMI Z-score	1.57±0.37	2.82±0.34	4.80±1.47	<0.001	<0.001	<0.001	<0.001
TBV (m ³)	1.384±66.52	1.449±86.38	1.570±46.87	<0.001	<0.001	<0.001	<0.001
OBV (mm ³)	61.04±13.54	71.34±12.69	59.80±17.28	<0.001	0.023	<0.001	<0.001
Corrected OBV ^a	43.76±9.50	49.29±8.61	38.23±11.52	<0.001	0.05	0.001	0.002
Right OBV ^b	21.92±4.94	24.98±4.53	19.20±5.85	<0.001	0.067	<0.001	<0.001
Left OBV ^c	21.83±4.34	24.31±4.32	19.02±5.64	<0.001	0.045	<0.001	<0.001
Δ OBV	0.08±1.22	0.67±1.94	0.18±0.63	0.174	0.455	0.238	0.381
PH (mm)	4.25±1.46	4.80±1.30	4.01±1.12	0.017	0.003	0.029	0.04
Corrected PH ^d	3.10±1.06	3.28±0.92	2.78±0.80	<0.001	<0.001	0.002	<0.001
Cholesterol	166.54±33.72	157.67±71.24	176.20±49.21	0.174	0.406	0.291	0.138
Triglyceride	106.9 ± 26.86	149.31 ± 81.29	185.95 ± 128.49	<0.001	<0.001	0.002	<0.001
HOMA-IR	2.43 ± 0.76	3.21 ± 1.34	4.07 ± 1.87	<0.001	<0.001	<0.001	<0.001

S: body surface, BMI: body mass index, TBV: total brain volume, OBV: olfactory bulb volume, PH: pituitary height

*p values: Each study group compared to normal weight group (Kruskal Wallis test was used) ^acorrected OBV: OBV/TBV (mm³/m³)

^bcorrected right OBV: right OBV/TBV (mm³/m³) ^ccorrected left OBV: left OBV/TBV (mm³/m³) ^dΔ OBV: Right OBV-Left OBV ^ecorrected PH: PH/TBV

Table 3: Partial correlation between BMI Z score and corrected total olfactory bulb volume

Correlations	Normal weight (n=89)			Children with overweight (n=31)			Children with Obesity (n=32)			Children with Severely Obesity (n=43)		
	Partial r ₈₉	p	df	Partial r ₃₁	p	df	Partial r ₃₂	p	df	Partial r ₄₃	p	df
TOBV	-0.204	0.396	86	0.275	0.041	28	0.377	0.034	29	-0.445	0.018	40
ROBV	0.054	0.615	86	0.247	0.188	28	0.217	0.346	29	-0.231	0.013	40
LOBV	0.133	0.217	86	0.213	0.213	28	0.237	0.529	29	-0.258	0.049	40

TOBV: corrected total olfactory bulb volume ROBV: corrected right olfactory bulb volume LOBV: corrected left olfactory bulb volume

BMI: body mass index. df: degree of freedom. Partial correlation was performed to show relationship between Z scores and OBV by adjusting brain volumes

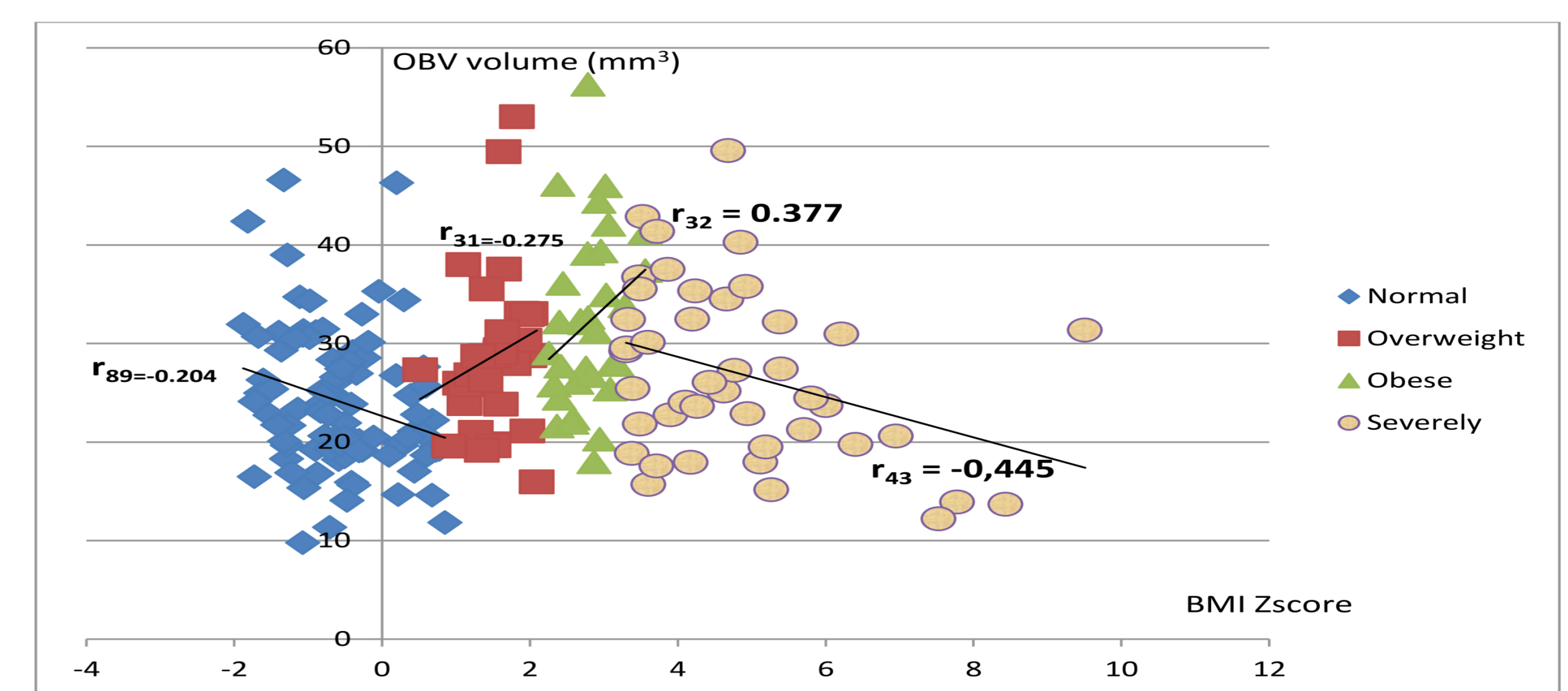


Figure 3: Correlations between olfactory bulb volume and BMI Z score in the control and study groups ($r_{89}=-0.204$, $r_{31}=0.275$, $p=0.041$; $r_{32}=0.377$, $p=0.034$; $r_{43}=-0.445$, $p=0.018$, respectively).

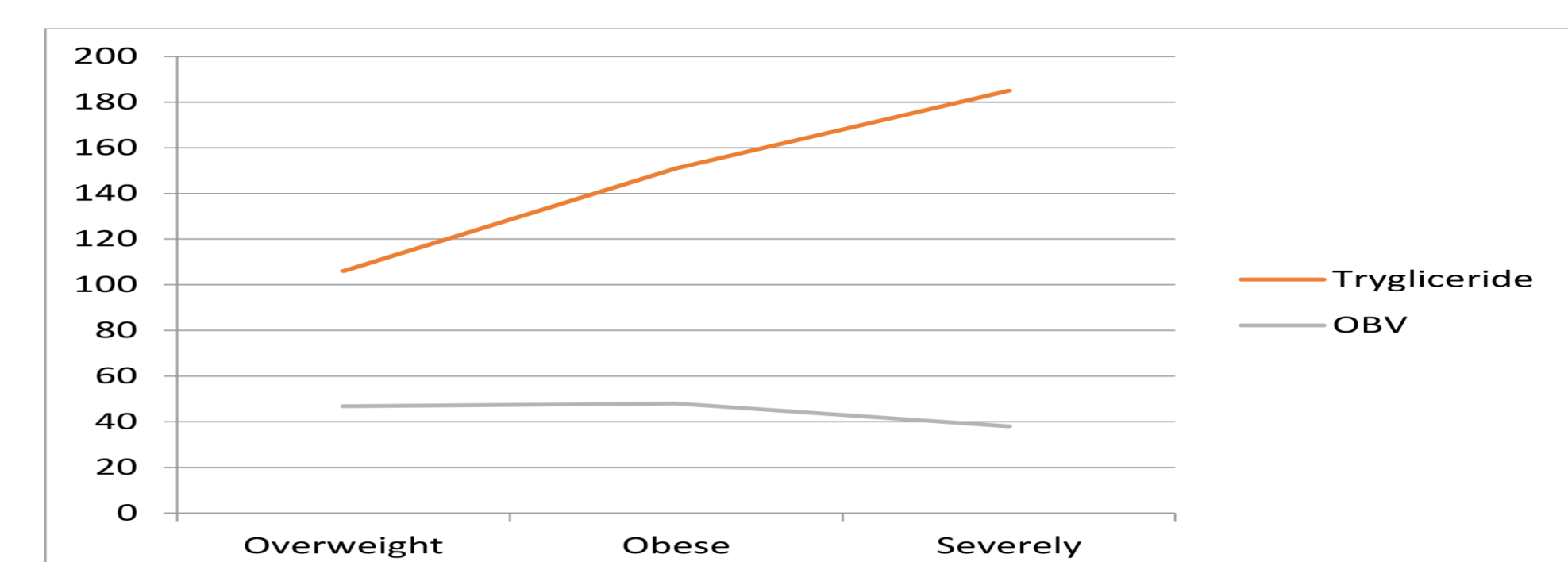


Figure 2: Triglyceride levels and corrected olfactory bulb volumes in the study groups (Triglyceride: mg/dl OBV: mm³)

This study indicates that there is a positive, albeit weak, correlation between olfactory bulb volume and BMI in the children with overweight and obesity, however, the correlation, albeit moderate, appeared inversely in the children with severe obesity. This finding may suggest that the olfactory bulb volume could change depending on BMI, although it does not demonstrate any cause-and-effect relationship.