Age-Related Changes with Selected Salivary Physical Properties and Caries Experience among Healthy Adult Men

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ABSTRACT

Introduction: *The caries process is characterized as a lifetime disease that occurs at an early phase of life. One of the most important factors which influence the development of dental caries is saliva.* ***Aim of the study:*** *The study was conducted to correlate the effect of ageing on selected physical properties of saliva and caries experience.* ***Methodology:*** *A cross-sectional comparative research was assessed among 90 healthy subjects (males only) who attended International Medical Center at Baghdad city. They were classified into 3 age groups (20 years, 40 years and 60 years) each age groups consisted of 30 subjects. The data was then statistically analyzed using SPSS version 22. Statistically, a significant difference was at p-value≤0.05.* ***Results:*** *The current study found that the increase in the mean value of caries experience represented by DMFs with an increase in age (7.27 ± 8.02), (22.07 ± 20.33), (60.37 ± 31.39) respectively. There was a highly statistically significant difference between different age groups (p≤0.01). The present study recorded decrease in the mean value of salivary flow rate and a slight increase in the mean value of salivary viscosity with an increase in the age with highly significant difference (p≤0.01) among different age groups, while salivary pH recorded approximately equal mean value with no significant difference among different age groups. The current study revealed a negative significant correlation between Ds fraction with salivary PH among the young age group, a positive correlation was recorded between (Ds) fraction with salivary viscosity among young and middle-aged groups.* ***Conclusion:*** *The present data suggest that with increasing age an increase in dental caries is experienced. There are significant age-related differences in salivary physical properties that can affect the caries experience.*

Keywords: Ageing, Caries experience, Salivary flow rate

INTRODUCTION

In spite of awareness burst in the science of cardiology, dental caries development still relics a misunderstood miracle by the researchers. In order to successfully use the comprehensive variety of preventive plans, it is domineering to look beyond those black and white spots that are noticeable on the tooth surfaces. Dental caries is a dynamic multifactorial disease which involves interactions between the tooth structures; the microbial agents formed on the tooth surface and fermented sugars, as well as saliva, age, race, genetic influence [1]. The fact that teeth are in constant contact and bathed by saliva suggests this environmental agent would profoundly influence the dental caries process. Aging is a time-dependent natural process which convoluted alteration in the organ structure of the body after maturity and the organs functions can increasingly change, it occurs totally over body organs so no one can spurt [2]. A number of age-related changes disturb the building of oral cavity of hard and soft tissues. The consequence of ageing on the physiology of salivary glands take controversial concerns, one of them hypothesized is any shifting in the physiological function of salivary gland with age progression are due to the path of time and are independent of extrinsic disturbance such as disease or medication [3,4]. Others related the decreasing in the function of saliva with increasing age which occurred as a result of external influence including systemic disease and medication. However, it well recognized that the shifting in the function of saliva is commonly associated with age-related disease and their medication [5,6]. Unfortunately, a little data is available concerning the effect of age on caries experience of a healthy adult.

PATIENTS AND METHODS

A cross-sectional comparative study conducted among 90 healthy subjects, only males were included in this study

that attended International Medical Center at Baghdad city for full body investigation and was treated if there was any need. The included subjects were classified into 3 age groups, 30 subjects in each group (20 years, 40 years and 60 years) with 6 months interval to prevent any bias. The age was recorded according to the criteria of the World Health Organization to the last birthday [7]. All subjects were under complete medical investigation. Patients who were non-medicated, non-smoker, with no medical history, shouldn't wear any removable or fixed dental appliance and they were permanent residents in Baghdad city were included in the study. Salivary samples were collected for each participant at fix time every morning (8 to11am). Collection of unstimulated whole saliva was done under standardized condition [8]. Oral examination and dental caries experience was done after saliva collection according to decayed (Ds), missing (Ms) and filled surface (Fs) (DMFs) index according to the criteria of WHO (1987) as it is a more sensitive index for caries intensity since it is measured in term of surfaces rather than teeth [9]. Dental caries experience was carried out by using dental explorer and plane mouth mirror. Salivary pH was measured for each sample by pH meter device. Determination of salivary viscosity was done by measuring the volume rate of flow through a tube of viscometer which is known as Ostwald viscometer [10].

Ethical Consent

The protocol of the project was approved by the research committee, College of Dentistry, University of Baghdad. Approval was achieved from the International Medical Center for examining the subjects and explains the purpose of this research and agreed to the research protocol. Each participant was informed about the purpose of the research, and informed consent was obtained from each subject.

Statistical Analysis

Statistics were reported by caries experience, salivary flow rate, salivary pH, and salivary viscosity for all participants in the 3 different age groups. The calculation of data was done using SPSS computer software version 22, one way ANOVA statistical analysis. Pearson's chi-square was used with $p < 0.05$, which was considered as statistically significant.

RESULTS

The recent investigation is showed in Table 1, caries experience increased with age, dental caries experience (DMFs) was found to be higher in the third age group (60.37 ± 31.39) followed by second age group (22.07 ± 20.33) and the lowest mean value was recorded among the first age group (7.27 ± 8.02). The same table revealed the missing (Ms) fraction was found to be the largest proportion of DMFs value when compared to Ds and Fs among all age groups and the old age group had the highest Ms fraction (52.60 ± 31.97) when compared with 40 years and 20 years old respectively (13.97 ± 15.23, 2.93 ± 6.09) with statistically higher significant difference ($p \leq 0.01$), and was recorded among all age groups.

Table 1 Caries experience by fractions (mean and standard deviation) among different age groups

Age (Years)	Variables	Mean	± SD	ANOVA	
				F	p-value
20	Ds	3.5	4.1	0.800	0.452
40		3.93	7.21		
60		5.3	5.52		
20	Ms	2.93	6.09	48.884	0.000*
40		13.97	15.23		
60		52.6	31.36		
20	Fs	0.83	1.72	2.317	0.105
40		4.27	7.84		
60		2.47	7.07		
20	DMFs	7.27	8.02	46.208	0.000*
40		22.07	20.33		
60		60.37	31.39		
*p<0.05 statistically significant					

The recent study revealed the mean value of salivary flow rate was higher among 20 years of age group and decrease

with increasing age until it reached half mean value at 60 years of age group. A statistically higher significant difference (p≤0.01) was recorded among the 3 age groups as shown in Table 2.

Table 2 Salivary flow rate (mean and standard deviation) among 3 age groups

Age (Years)	Variables	Mean	±SD	ANOVA	
				F	p-value
20		0.49	0.22		
40	Flow rate (ml/min)	0.42	0.2	12.171	0.000*
60		0.25	0.17		
p≤0.05 statically significant					

The mean value of salivary pH was slightly equal among different age groups. Statistically, there was no significant difference among different age groups as shown in Table 3.

Table 3 Salivary potential hydrogen (mean and standard deviation) among 3 age groups

Age (Years)	Variable	Mean	±SD	ANOVA	
				F	p-value
20		6.45	0.55		
40	pH	6.60	0.48	1	0.372
60		6.62	0.42		
p≤0.05 Non-significant					

Concerning, salivary viscosity a higher mean value among the old age group which recorded double mean value when compared with the mean value of the other two age groups. However, the results showed the same mean value of salivary viscosity among young and middle age group, statistically higher significant difference was seen among 3 age groups as demonstrated in Table 4.

Table 4 Salivary viscosity (mean and standard deviation) among 3 age groups

Age (Years)	Variable	Mean	±SD	ANOVA	
				F	p-value
20		0.01	0		
40	Viscosity (pois)	0.01	0	31.386	0.000*
60		0.02	0		
p≤0.05 statically significant					

Regarding the correlation of salivary flow rate with caries experience among young age group, the Table 5 illustrates that a significant correlation was recorded with Ds fraction, while a negative and no significant correlation with Ms and Fs fractions. Concerning middle-age group, the same table illustrates that a negative significant correlation has been found with Ds fraction, in addition, a strong positive highly significant correlation with Fs fraction. However, no significant correlation was recorded with Ms and DMFs among 3 age groups. Among old age group the same table revealed the correlations between salivary flow rate and caries experience, a significant correlation was recorded with Ds fraction. However, statistically, the result failed to record any significant correlation with other DMFs fractions among old age group as demonstrated in Table 5.

Table 5 Correlations coefficients between salivary flow rate with caries experience among differences age groups

Variables	Age (Year)	DS		MS		FS		DMFs	
		r	p	r	p	r	p	r	p
F.R (ml/min)	20	0.403	0.027*	-0.016	0.933	-0.077	0.685	0.177	0.349
	40	-0.348	0.036*	-0.118	0.533	0.626	0.000*	0.007	0.972
	60	0.409	0.025*	0.251	0.181	0.293	0.116	0.034	0.389
p≤0.05 statistically significant									

Concerning the correlation coefficient between salivary pH with caries experience among different age groups as illustrated in Table 6. In the first age group, negative correlations were recorded between pH and Ds, Ms, and DMFs, while positive correlations with Fs fractions. Statistically, a significant correlation was recorded between salivary

pH and Ds fraction among 20 years age group. Concerning the second age group, a positive correlation was found between pH with Ds, Fs, DMFs fractions while negative correlations with Ms fraction. However, the findings failed to find any significant correlations between pH and caries experience among the middle age group. Old age group, the same table illustrates that highly significant correlations were recorded between salivary pH and DMFs in addition to Ms fraction as shown in Table 6.

Table 6 Correlation coefficients between salivary pH with caries experience among different age groups

Variables	Age (Year)	DS		MS		FS		DMFs	
		r	p	r	p	r	p	r	p
pH	20	-0.382	0.037*	-0.092	0.627	0.03	0.876	-0.259	0.166
	40	0.042	0.825	-0.074	0.697	0.282	0.876	0.061	0.749
	60	0.128	0.501	0.507	0.004*	0.211	0.264	0.577	0.001*
p≤0.05 statically significant									

The current investigation revealed that a positive correlation was found between salivary viscosities with Ds, Fs, DMFs fraction among the first age group. However, the current findings failed to record any significant correlation among this age group. Concerning the middle age group, a positive correlation was found between salivary viscosity and Ds fraction while a negative correlation with other fractions with no significant correlations was recorded. The same table illustrates that significant positive correlations were recorded between salivary viscosity with Ms and DMFs fractions among old age group as shown in Table 7.

Table 7 Correlation coefficients between salivary viscosity with caries experience fraction among different age groups

Variables	Age(Year)	DS		MS		FS		DMFs	
		r	p	r	p	r	p	r	p
Viscosity (pois)	20	0.052	0.784	-0.053	0.779	0.224	0.235	0.034	0.858
	40	0.018	0.927	-0.053	0.754	-0.217	0.249	-0.031	0.872
	60	-0.279	0.135	0.442	0.014*	-0.038	0.841	0.384	0.384
p≤0.05 statically significant									

DISCUSSION

In the current cross-sectional comparative study, caries experience was conducted among 90 participants (only males) to overcome the hormonal and physiological variation between genders that is found to have a different effect on oral health and to reduce the intergroup and intragroup differences [11,12]. Unfortunately, a little data is available concerning the effect of age on caries experience of healthy adult among the Iraqi population, particularly between ages (20 to 60) years old to compare with, for that the comparison was done with the normal population of other studies nearly with the same range of age group of recent study.

Statistically, a highly significant difference existed in the current study between the DMFs among all age groups (p<0.01) and these result were in accordance with the finding of Farsi in 2008 who recorded the old adult have higher DMFs than middle-aged with a statistically highly significant difference [13]. However, the result of the present study disagrees with another study [14]. These variations in the findings of the studies may be related to many factors as dental caries is a multifactorial disease, in addition to, sample size and method of dental caries examination [15,16].

Concerning the mean value of the rate of resting saliva secretion (salivary flow rate) among different age groups, the current study recorded, salivary flow rate decreased with age but still within the normal range of unstimulated saliva (0.25 to 0.35) ml/min [17]. This may be due to the fact that all subjects in the present investigation were healthy un-medicated subjects, salivary flow rates were found to be relatively unaffected in the absence of additional challenges like systemic diseases and different medications, the result of the current study is in accordance with other studies [18,19]. In addition, there was a hypothesis concerning the impact of age on resting salivary flow rate as a result of age-related changes, in the structure of salivary glands which included loss of salivary acinar cells, acini and ductal volume, and loss of gland parenchyma and increases the diffusion of adipose cells in the gland parenchyma all that may lead to dropping within the resting salivary flow rate with different limit [4,20].

Concerning young adults and middle-aged, the current study revealed that the mean value of salivary flow rate was (0.49 ± 0.22) and (0.42 ± 0.20) respectively which was higher than the range of normal values of rest saliva (0.25 to

0.35) ml/min [17]. This may be related to the statistically significant differences among groups of recent study which produce an impressions that, the age-related changes in the structure of salivary glands didn't occur at young and even at middle age for that they have highly resting saliva with no significant differences and maybe there were healthy subjects, and this comes in agreement with the findings of Jonathan, et al. who stated the salivary flow does not consistently go along with the aging in healthy persons, because salivary glands possess a functional reserve capacity probably due to significant functional reserves within salivary glands [4].

Regarding the correlation coefficient of salivary flow rate with caries experience among different age groups, the present study showed a positive significant correlation between Ds fraction and 20 years, 60 years old. The current finding goes with reported by other studies [21,22]. This may be related to other factors rather than salivary flow rate alone which lead to positive significant correlation with Ds fraction in this investigation like buffer capacity, salivary clearance, and factors with salivary gland function. In contrast the middle age groups in the current study showed inverse significant correlation with Ds fraction in addition to strong positive highly significant correlation with Fs fraction probably because this age group (40 years old) takes care of their oral health and they are highest filled teeth surfaces, which are consistent with observation of other [23].

In the current study, the mean value of salivary pH was within the normal mean value of salivary pH [24]. It was almost equal among 20 years, 40 years and 60 years old (6.4 ± 0.55), (6.60 ± 0.48), (6.62 ± 0.42) respectively with no significant differences, probably due to the reason as all the selected groups were a healthy participant. This result is nearly similar to that found by Bnoosh and slightly lower than the result of others [25-27]. These slight differences between the results could be attributed to a variety of age groups of studies, the time interval between salivary collection and pH measurement [28]. In addition, certain factors which are not included in the current study like oral clearance of saliva, buffering capacity, the ecology of the oral cavity, oral cleanliness of patients and so on [29,30].

The present study revealed the correlation coefficient between salivary pH and caries experience among different age groups. The current study revealed a negative significant correlation with Ds fraction among young age group, that means an increase in salivary pH will enhance tooth remineralization, this result comes with the agreement with the findings of others [31,32], while among middle age and old adult age group salivary PH of current study showed no association with dental caries and this was consistent with other studies that were found with advancing caries, salivary pH was a poor indicator of caries risk and this factor may interfere with it but in contrast with finding of Farsi in 2008 who found the highest significant pH with low caries group [13,33]. Regarding (Ms) fraction in relation with salivary pH, the current study showed an inverse correlation with (Ms) fraction among young and middle age groups, this may be supported with a high percentage of caries-free surfaces and a low percentage of missing surfaces among both age groups in the current investigation. Among old adult, who recorded the highest mean value of (Ms) fraction, the present study revealed a highly significant correlation with Ms fraction and DMFs. This may be due to the findings of the current study which recorded a very high mean value of Ms fraction and DMFs index among the old age group which may statistically reveal a highly significant correlation between the physical variables.

Salivary viscosity in the current investigation recorded increasing in the salivary viscosity with old adult, that recorded double value when compared with both other age groups and statistically highly significant difference, the explanation related to the little effect of age on healthy subjects that leads to stay of salivary flow rate within the normal value of resting flow rate among old subjects as mentioned previously, while there was no significant difference evaluated between first and second age group, this may be supported with no significantly different with flow rate, this result in accordance with the finding of while disagreement with another study that showed the salivary viscosity decreased with age [34-36].

Regarding the correlation coefficient between salivary viscosities with caries experience among different age groups, the present investigation showed a positive correlation between (Ds) fraction and salivary viscosity among young and middle-aged groups that could be related to the levels of MUC5B mucin. MUC5B is not only related to rheological, but also biochemical properties that the molecule of mucin consists of ~20 wt % protein and ~80 wt.% carbohydrate. The carbohydrate portion on some salivary glycoprotein (mucin) molecules in the pellicle may serve as receptors for bacterial binding proteins and may contribute to bacterial adhesion to the tooth [37], the current result accordance with the previous result of another study, who recorded salivary viscosity associated with dental caries [38].

CONCLUSION

The thoughtful elaboration of the normal age-related physiologic changes in saliva is an imperative manner, as well as rise in awareness and attention to recognize oral health impairment at early time because oral health is associated with general health, that oral substance involving teeth and gum which can significantly affect over totally well-being and capability to oldness positivity.

DECLARATIONS

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

REFERENCES

[1] Nigel, B. Pitts, et al, Francisco Ramos-Gomez, Junji Tagami, Svante Twetman, Georgios Tsakos and Amid Ismail. ''Dental caries''. *Nature Reviews Disease Primers*, Vol. 3, No. 17030, 2017, pp. 1-15.

[2] Chul, Ho Chang, Ki-Young Lee, Yon Hee Shim. ''Normal aging: definition and physiologic changes''. *Journal of Korean Medical Association*, Vol. 60, No. 5, 2017, pp. 358-36.

[3] Busse, E.W. *''Theories of ageing''* In Busse E.W. Pfeiffere. (Eds), Behavior and Adaptation in later life. Little, Brown and Company, Boston, pp. 8-30.

[4] Jonathan, A. Ship, Poul Holm-Pedersen, Angus W. G. Walls. ''Textbook of Geriatric Dentistry'' Ageing of organ system, Vol.3, 2015, pp. 12-13.

[5] Närhi, TO, et al. ''Association between salivary flow rate and the use of systemic medication among 76-81 and 86 years old inhabitant in Helsinki, Finland.'' *Journal of Dental Research*, Vol. 71, 1992, pp.1875-80.

[6] Hamad, Abdullah I., Riyadh O. Alkaisi, and Intesar J. Alkaisi. ''Flow rates of resting whole saliva of diabetic patients in relation to age and gender'', *Tikrit Journal for Dental Sciences*, Vol. 1, 2012, pp. 1-5.

[7] World Health Organization. ''Oral health surveys, basic methods.'' World Health Organization, Geneva Switzerland, 1997.

[8] Navazesh, M., and Kumar**,** S. "Measuring salivary flow Challenges and opportunities." *Journal of America Dental Association*, Vol. 139, No. 5, 2008, pp. 35-40.

[9] World Health Organization. ''Oral health surveys, basic methods.'' World Health Organization, Geneva Switzerland, 1987.

[10] Shridhar Gadre, R. "Century of Nobel Prizes: 1909 Chemistry Laureate Wilhelm Ostwald (1853–1932)." *Resonance,* Vol. 8, No. 1, 2003, pp. 77-83.

[11] Al-Zahawi, Shukria Mohammad, and Ali Sultan Al-Refai. "The relationship between calcium, magnesium and inorganic phosphate of human mixed saliva and dental caries." *Mustansiriya Dental Journal*, Vol. 4, No. 2, 2012, pp. 157-61.

[12] Al-Souz, Ban T., and Wesal A. Al-Obaidi. "Salivary antioxidants in relation to dental caries among a group of lead-acid batteries factory workers." *Journal of Baghdad College of Dentistry*, Vol. 27, No. 1, 2015, pp. 159-63.

[13] Farsi N. ''Dental caries in relation to salivary factors in Saudi population groups''. *Journal Contemporary Dental Practice*, Vol. 9, No. 3, 2008, pp. 66-68.

[14] Ship, J.A, and I.I. Ship. ''Trends in oral health in the aging population''. *Dental Clinic of North America,* Vol. 33, 1989, pp. 33-42.

[15] Baghdadi. Z. ''Improving Oral Health Status of Children in Tabuk, Saudi Arabia'', *Dental Journal,* Vol. 2, No. 1, 2014, pp. 22-40.

[16] Wen. A, et al. ''Caries Resistance as a Function of Age in an Initially Caries-free Population'', *Journal of Dental Disease*, Vol. 91, No. 7, 2012, pp. 671-75.

[17] Avery, David R., and Ralph E. McDonald. *Dentistry for the child and adolescent*. Mosby, 2004, pp. 54-56.

[18] Yas, B. ''Salivary antioxidants and physicochemical characteristics related to oral health status among a group of old adults.'' 2009, College of Dentistry, University of Baghdad.

[19] Jaafar I. ''Cognitive impairment-Alzheimer disease-among retirees in relation to oral health condition and salivary physicochemical characteristics related to gene detection and body composition in Middle Euphrates Region-Iraq''. 2017, College of Dentistry, University of Baghdad.

[20] Kazim, Talib J., and Ali Ghanim Abdulla. "Age-Related Changes of Submandibular Salivary Glands (Ultrasonographic and Structural Study)." *Diyala Journal of Medicine*, Vol. 1, No. 1, 2011, pp. 53-63.

[21] Ghulam, I. ''Oral health status in relation to salivary variables among a group of asthmatic patients''. 2007, College of Dentistry, University of Baghdad.

[22] Al-Saadi, A. ''Oral health conditions and salivary constituents among selected overweight primary school children''. 2009, College of Dentistry, University of Baghdad.

[23] El-Samarrai S. ''Major and trace element contents of permanent teeth and saliva among a group of adolescents in relation to dental caries, gingivitis and mutans streptococci (in vitro and in vivo study)''. 2001, College of Dentistry, University of Baghdad.

[24] Sharmila Baliga, Sangeeta Mugliker, Rahul Kal. ''Salivary pH: A diagnostic biomarker'', *Journal Indian Soial Periodontal*, Vol. 17, No. 4, 2013, pp. 461-65.

[25] Bnoosh. S. ''Some salivary parameters in relation to dental caries- experiences.'' *Kirkuk University Journal*, Vol. 10, No. 3, 2015, pp. 292-303.

[26] Ali, Basima Gh, and Omar Husham Ali. "Detection of salivary flow rate and minerals in smokers and non-smokers with chronic periodontitis (Clinical and Biochemical study)." *Journal of Baghdad College of Dentistry*, Vol. 24, No. 1, 2012, pp. 68-71.

[27] AL-Awadi. R. ''Oral Health Status, Salivary Physical Properties and Salivary Mutans Streptococci Among A Group of Mouth Breathing Patients in Comparison to Nose Breathing (Comparative Study).'' 2012, College of Dentistry, University of Baghdad.

[28] Foglio-Bonda, P. L., et al. "Daily and annually variation of unstimulated whole saliva flow rate and pH and their relation with body profile in healthy young adults. *Eurasian Review Medical Pharmacological Science*, Vol. 17, No. 18, 2013, pp. 2538-3852.

[29] Tenovuo J, Lagerlöf F. ''Saliva. In Textbook of clinical cardiology etd''. Munksgaard, Copenhagen, 1994, pp. 17-43.

[30] Edgar, Michael, and Susan M. Higham. "Saliva and the control of plaque pH." *Saliva and Oral Health,* Vol. 3, 2004, pp. 72-86.

[31] Jawed, M, et al. ''Salivary calcium, phosphate and fluoride in dental caries''. *Journal Ayub Medical College Abottab*, Vol. 12, No. 4, 2000, pp. 3-5

[32] Rockenbach M, Marinoho S, Veeck E, Lindemann L, Shimrai R. ''Salivary flow rate, pH and concentration of calcium, phosphorus, and sIgA in Brazillian pregnant and non-pregnant women''. *Head Face Med*, Vol. 2, 2006, pp. 44-51.

[33] Närhi TO, Kurki N, Ainamo A. ''Saliva, salivary microorganisms and oral health in the home-dwelling old elderly-a five-year longitudinal study''. *Journal of Dental Researches,* Vol. 78, No. 10, 1999, pp. 1640-46.

[34] Zussman, E.Yarin, A. and Nagler, R. '' Age-and flow dependency of saliva viscoelasticity''. *Journal of Dental Researches*, Vol. 3, 2007, pp. 281-85.

[35] Yas, B. and Radhi. N. ''Salivary Viscosity in Relation to Oral Health Status among a Group of 20-22 Years Old Dental Students''. *Iraqi Journal of Community and Medicine*, Vol. 3, 2013, pp. 219-24.

[36] Nagler RM and Hershkovich O. ''Age-related changes in unstimulated salivary function and composition and its relation to medications and oral sensorineural complaints''. *Aging Clinical Experience Research*, Vol. 17, No. 5, 2005, pp. 358-66.

[37] Nunn, June H., and James G. Steele. The prevention of oral disease. Oxford University Press, 2003.

[38] Gopinath, VK, and A. R. Arzreanne. ''Saliva as diagnostic tool for assessment of dental caries''. *Oral Facial Sciences*, Vol. 1, 2006, pp. 57-9.