

COMPARATIVE ANALYSIS OF DIFFERENT LENS MATERIALS

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ABSTRACT

Background: The purpose of this study is to subjectively judge the performance of polycarbonate lenses to Trivex® lenses in high prescriptions of at least 4 diopters plus or minus or at least 2.5 diopters of cylinder, using survey based subjective analysis. Trivex® and polycarbonate are two lenses that have similar characteristics with the exception of Abbe values, which are 44 and 30 respectively. Attributes measured were thickness, vision quality through central and peripheral portions of lens, importance of impact resistance, and overall rating.^{1,2}

Methods: Subjects wore each type of lens material for 7-10 days. At the end of each period a survey was completed will to examine the performance of the lens material. Following the second trial period each participant also completed a survey comparing the performance of each lens material. Patients were not informed of the specific type of lens material that they are wearing in order to limit the influence of prior knowledge of the results.

Results: Trivex® outperformed polycarbonate in all categories (central/peripheral clarity and overall rating) with exception of lens thickness. Impact resistance was rated moderate in the buying decision of subjects in choosing a lens material.

Conclusions: Subjective analysis in this study showed that in patients with higher prescriptions Trivex® was preferred over polycarbonate for lens material.

TABLE OF CONTENTS

	Page
LIST OF TABLES.....	vi
INTRODUCTION	1
METHODS.....	1
RESULTS.....	2
DISCUSSION.....	3
TABLES.....	5-12
REFERENCES.....	13

LIST OF TABLES

Table		Page
1	Survey #1 Polycarbonate Results.....	5
2	Survey #2 Trivex® Results.....	6
3	Statistical Analysis of Survey #1 and #2.....	7-8
4	Survey #3 Comparison Results.....	9
	a. Which Lens Had Greater Clarity?.....	10
	b. Bothersome Effects Through Central Portion?.....	10
	c. Bothersome Effects In Periphery?.....	11
	d. Which Had More Cosmetic Benefits?.....	11
	e. If Both Lenses Same Price, Which Would You Buy?.....	12

Introduction

A comparison between polycarbonate and Trivex is useful for optometrists, opticians, and lens manufacturers. Optometrists and opticians should recognize differences between these lens materials in order to make the best recommendation to patients. Lens manufacturers may benefit from subjective input based on surveys thereby determining the value derived from one product versus the other.

Polycarbonate has a refractive index of 1.586 and a low abbe value of 30. This low abbe value compromises peripheral viewing through the lens due to increased chromatic aberration. Polycarbonate has historically been used for children and monocular patients for the impact resistance qualities inherent.^{1,2,3}

Trivex® has a refractive index of 1.530 and a relatively higher abbe value of 44. This high abbe value results in reduced chromatic aberration and clearer peripheral viewing. Trivex® material is less dense than polycarbonate and is thus lighter in weight. One drawback of Trivex® is the lower refractive index resulting in a thicker lens.^{1,2}

Although these products have different characteristics, the perception of these materials tested by volunteers may give further insight on them. The lenses were compared based on attributes of thickness, vision quality through central and peripheral portions of the lens, importance of impact resistance, and overall rating.

Methods

Subjects selected in this study ranged in age between 21 and 34 years old, and all had prescriptions of at least plus or minus four diopters or at least two and a half diopters

of cylinder in their spectacle prescription. Subjects had spectacle created with two sets of lenses made, one set of polycarbonate and one set of Trivex®. Subjects were not informed of the type of lens material used in either trial period in order to eliminate subject bias as much as possible.

Subjects wore each set of lenses for a trial period of seven to ten days, allowing for adaptation to each lens material. Following each trial period subjects completed a survey on the performance of that particular lens material. The survey completed after each trial period were identical and included analysis of image quality through, central and peripheral portions of the lens, importance of impact resistance, and overall rating. Following the completion of the second trial period a comparison survey was given in which subjects compared the performance of each lens material in the areas of quality through central and peripheral portions of the lens, importance of impact resistance, preferred lens material, and how much more the preferred lens material was worth.

Results

The results of the findings are favorable toward Trivex® as being the superior product with exception of lens thickness. The refractive index difference causes a mild change in thickness between the two materials favoring polycarbonate. However, the mean value difference between the two is very minimal: $7.62 - 7.38 = 0.24$. Central clarity, peripheral clarity, recommendations to friends, and overall ratings favor Trivex® versus polycarbonate material. The mean score of Trivex® (7.23) over polycarbonate (4.77) in peripheral viewing clarity is significant. The overall score favored Trivex® above polycarbonate by one point out of ten.

Impact resistance cannot be measured with a short trial period coupled with normal daily activities. This study showed that impact resistance was rated 6.1/10 on average for importance in the buying decision of lenses for the subjects of this study.

As a result of the benefits of Trivex®, 85% of volunteers would choose it if both lenses were the same price. Of that 85%, the average monetary premium a volunteer would pay is \$31 for the benefits. The 15% of volunteers who chose Polycarbonate as their favored lens of choice would pay an average of \$45 premium. Also, nine out of thirteen candidates would recommend polycarbonate to a friend compared to twelve of thirteen for Trivex®.

The study was statistically significant due to the majority of z scores (1 exception) within the ± 1.96 range signifying 95% confidence. Standard deviation between the 1-2 range shows relative consistency between volunteers. The sample size of thirteen volunteers is small and each individual has greater effect toward the study.

Discussion

The data showed many predictable yet interesting results depending on how questions were asked. In the comparison survey, 62% of volunteers stated both lenses had bothersome effects in the periphery. Furthermore, survey #1 and #2 showed Trivex® outperforming polycarbonate by roughly 2.5 points on average. Trivex® marginally scored higher on central clarity. Overall scores also favored Trivex® by one point.

This study determined subjectively that Trivex® is a superior product than polycarbonate in the majority of circumstances. The volunteers subjectively rated Trivex® with higher marks without knowing what types of lenses they wore. This study may be useful in aiding consumers in the buy decision between polycarbonate versus

Trivex® and that the premium paid is reasonable based on the survey. Prospective buyers should be educated on the peripheral viewing clarity benefits of Trivex® and the light weight design. On the other hand, polycarbonate should not be dismissed as a poor quality product. It is placed at a proper price point in comparison to Trivex® and caters to value minded buyers or children due to its excellent impact resistance. The study determined that impact resistance scored a 6.1/10 on average for importance in buy decisions. The sample size with an average age of 25 tested may lead to variable results in the importance of impact resistance. Therefore, it is expected that impact resistance to be more important in parents purchasing eyewear for their children or in those vocation or avocations create higher risk for eye injuries. These groups were not included in this study and should be considered in future evaluations.

Overall, further testing comparing polycarbonate to Trivex® would be highly beneficial both to increase the statistical significance and to show in what areas the performance of each lens material differs. Another area that further testing would benefit would be in expanding the testing parameters to determine at what point in a spectacle prescription do the benefits of Trivex® outweigh the increase in price over polycarbonate.

Table 1**Survey #1 Polycarbonate**

Volunteer #	Age	Thickness	Central	Peripheral	Impact Re- sistance	Recommend	Overall
1	25	5	8	5	4	Y	7
2	27	8	8	3	4	N	5
3	24	10	7	4	8	Y	7
4	24	8	6	7	8	Y	7
5	24	8	8	6	6	Y	7
6	26	6	8	5	4	Y	6
7	25	7	9	3	8	N	6
8	23	8	8	3	6	N	5
9	25	9	9	5	5	Y	7
10	34	7	9	6	6	Y	8
11	20	8	8	7	9	Y	9
12	27	8	6	3	6	N	6
13	21	7	9	5	4	Y	8
Mean	25.00	7.62	7.92	4.77	6.00	9.00	6.77
Median	25.00	8.00	8.00	5.00	6.00	4.00	7.00
SD	3.39	1.26	1.04	1.48	1.78	13.00	1.17

Table 2**Survey #2 Trivex**

Volunteer #	Age	Thickness	Central	Peripheral	Impact Re- sistance	Recommend	Overall
1	25	7	7	7	3	Y	7
2	27	7	9	5	3	Y	7
3	24	7	7	4	7	Y	7
4	24	6	10	7	8	Y	8
5	24	5	6	7	6	Y	6
6	26	9	10	7	8	Y	8
7	25	7	9	9	8	Y	9
8	23	8	9	6	6	N	6
9	25	8	8	8	4	Y	8
10	34	7	9	8	6	Y	8
11	20	8	9	9	9	Y	9
12	27	9	9	8	7	Y	9
13	21	8	9	9	5	Y	9
Mean	25.00	7.38	8.54	7.23	6.15	12.00	7.77
Median	25.00	7.00	9.00	7.00	6.00	1.00	8.00
SD	3.39	1.12	1.20	1.54	1.95	13.00	1.09

Table 3**Survey #1 Polycarbonate**

Volunteer #	Z score Thickness	Z score Central	Z score Peripheral	Z score Overall
1	-2.07	0.07	0.16	0.20
2	0.31	0.07	-1.19	-1.52
3	1.89	-0.89	-0.52	0.20
4	0.31	-1.85	1.51	0.20
5	0.31	0.07	0.83	0.20
6	-1.28	0.07	0.16	-0.66
7	-0.49	1.04	-1.19	-0.66
8	0.31	0.07	-1.19	-1.52
9	1.10	1.04	0.16	0.20
10	-0.49	1.04	0.83	1.06
11	0.31	0.07	1.51	1.91
12	0.31	-1.85	-1.19	-0.66
13	-0.49	1.04	0.16	1.06

Table 4**Survey #2 Trivex**

Volunteer #	Z score Thickness	Z score Central	Z score Peripheral	Z score Overall
1	-0.34	-1.28	-0.15	-1.62
2	-0.34	0.39	-1.45	-1.62
3	-0.34	-1.28	-2.10	0.43
4	-1.24	1.22	-0.15	0.95
5	-2.13	-2.12	-0.15	-0.08
6	1.44	1.22	-0.15	0.95
7	-0.34	0.39	1.15	0.95
8	0.55	0.39	-0.80	-0.08
9	0.55	-0.45	0.50	-1.10
10	-0.34	0.39	0.50	-0.08
11	0.55	0.39	1.15	1.46
12	1.44	0.39	0.50	0.43
13	0.55	1.04	1.15	-0.59

Table 5**Survey #3 Comparison**

Volunteer #	Age	Clarity	Central	Peripheral	Cosmetic	Preferred material	How much more is preferred material worth?
1	25	T	N	Both	Equal	T	\$25
2	27	T	N	Both	T	T	\$45
3	24	Equal	N	Both	Equal	P	\$55
4	24	T	Y	Both	Equal	T	\$35
5	24	P	N	T	P	P	\$35
6	26	Equal	N	T	T	T	\$45
7	25	T	N	P	Equal	T	\$35
8	23	T	N	Both	T	T	\$45
9	25	P	N	Both	P	T	\$5
10	34	Equal	N	P	T	T	\$15
11	20	T	N	Both	P	T	\$25
12	27	T	N	P	T	T	\$25
13	21	T	N	Both	T	T	\$45

T denotes Trivex

P denotes Polycarbonate

Table 5a

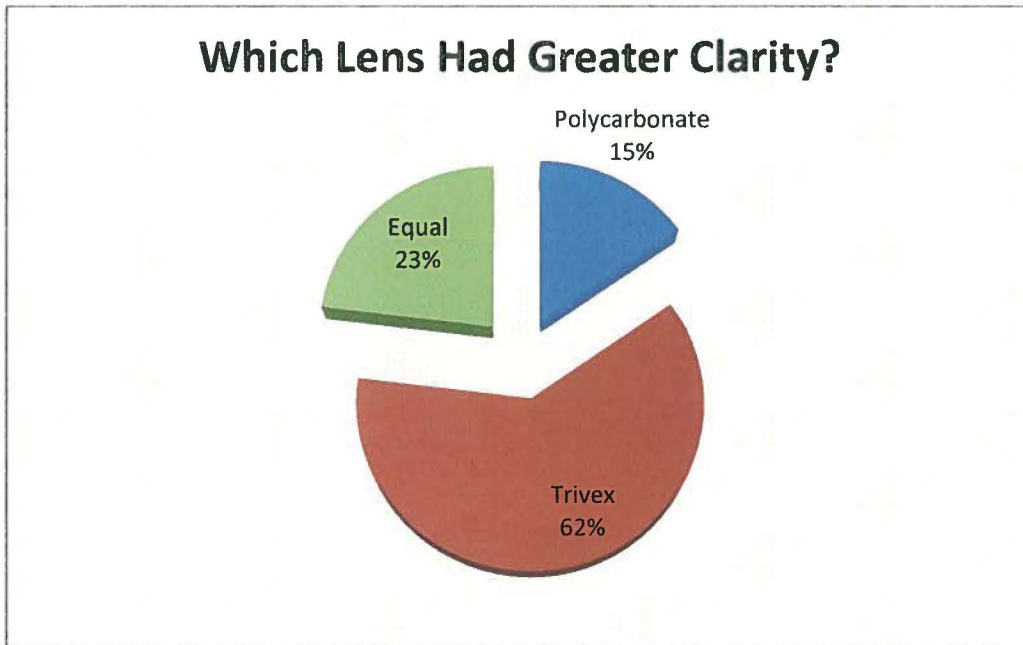


Table 5b

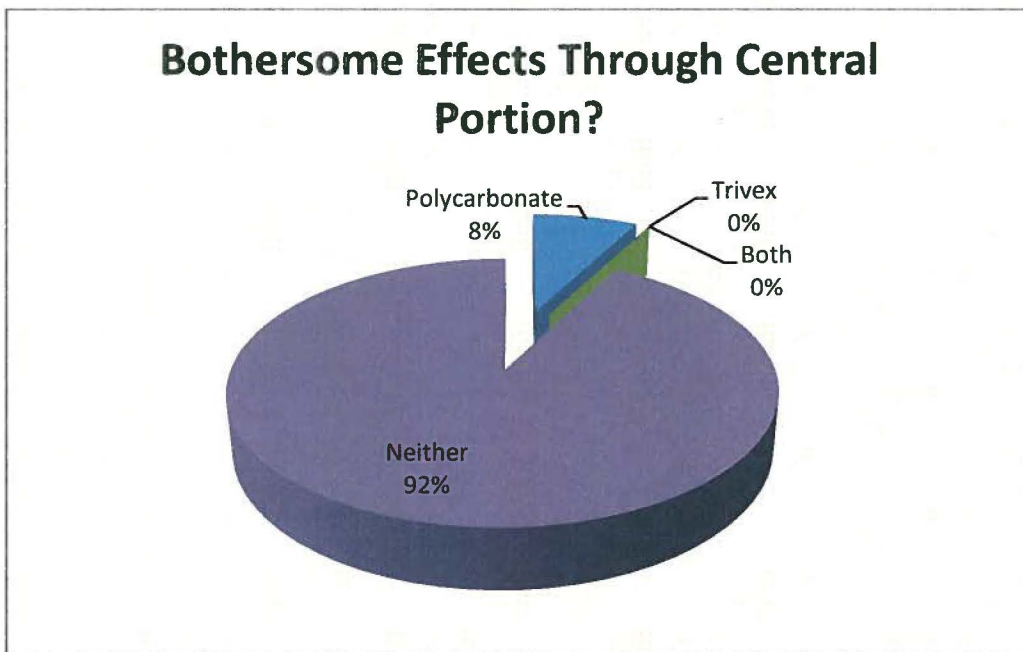


Table 5c

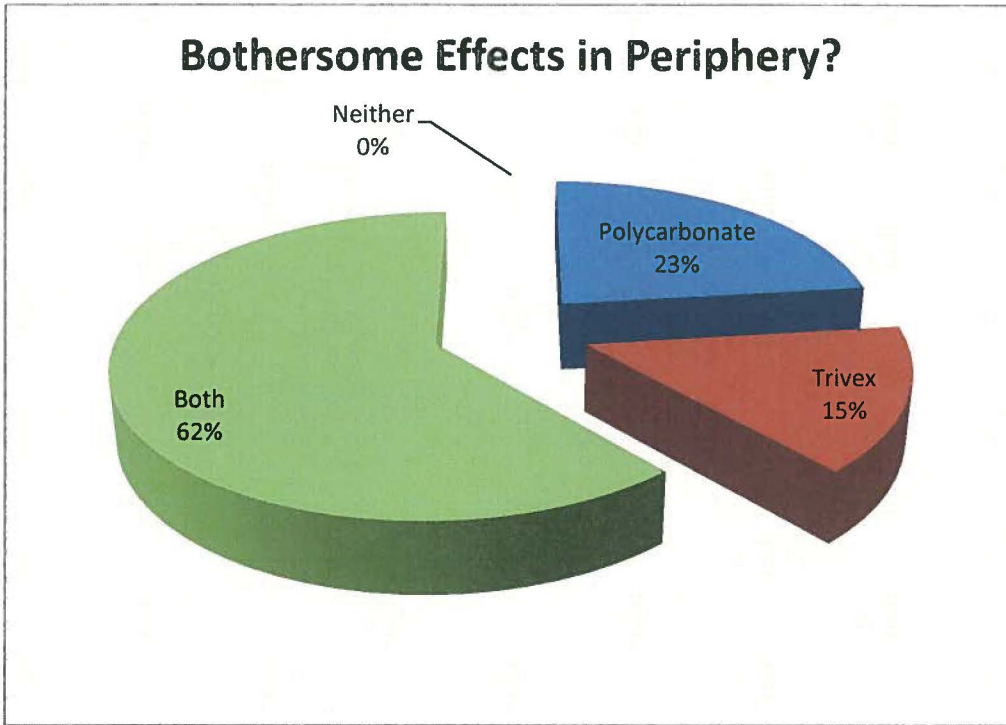


Table 5d

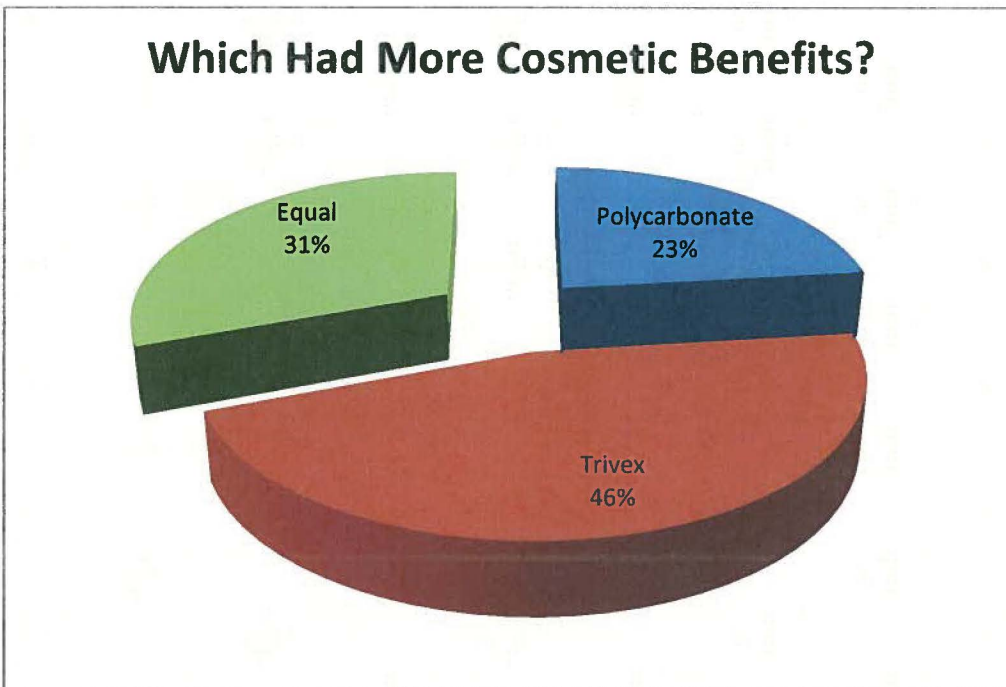
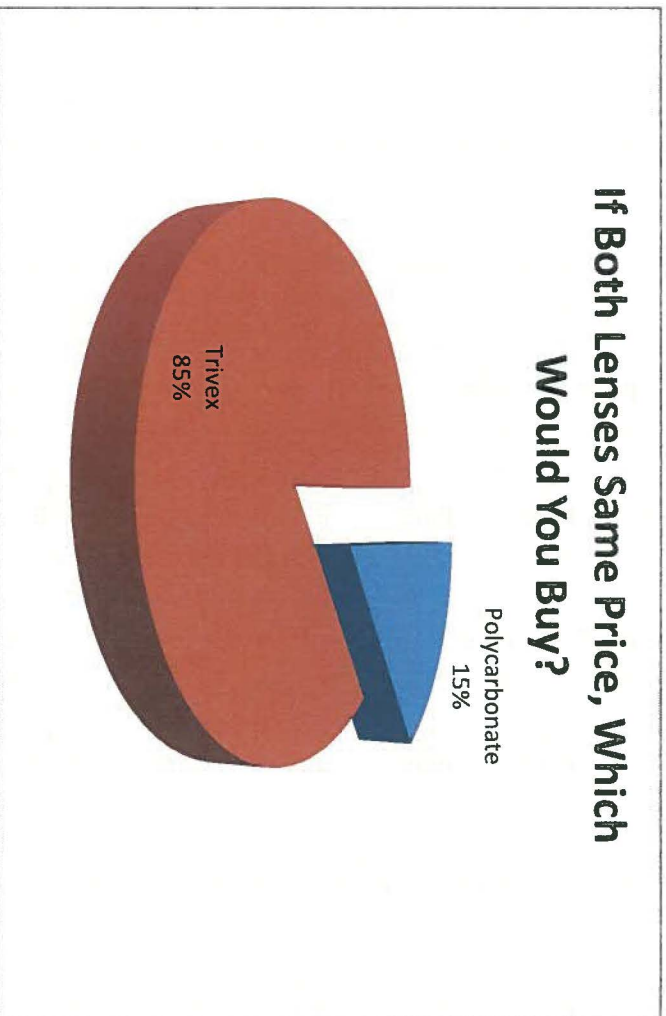


Table 5e



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