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Circuit Training to Increase Cardiorespiratory Endurance in Male Basketball Players

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Abstract

In playing basketball, body fitness is important. It is closely related to biomotor abilities which consist of several components, one of which is endurance. An attack movement in a basketball game would require good cardiorespiratory endurance. Aerobic endurance is related to oxygen intake.This study aims to determine the improvement of cardiorespiratory endurance in male students who took basketball as a preferred extracurricular activity gained through circuit training. This is experimental research with one-group pretest-posttest design. The sample of this research consisted of 15 male students. Circuit training was carried out three times a week for four weeksat an exercise intensity of 65%–90% of maximum heart rate. From hypothesis testingwitha paired t-test,it was found out that P = 0.000 (0.000 < 0.05), suggesting that there was a meaningful difference. This result shows that circuit training improved cardiorespiratory endurance.

Keywords: *circuit training, cardiorespiratory endurance, male basketball players*

Introduction

Basketball games are considered to be one of the most dynamic and flexible sports which require high levels of physical fitness[1]. Physical relations are associated with biomotor abilities because biomotor abilities are the abilities to measure human performance[2]. One of these biomotor components greatly affects a person's endurance, namely resilience. Resilience is the ability of the heart, lung, and blood vessels to work optimally when carrying out activities for a long time without experiencing interference[3]. Resilience can be grouped into anaerobic resistance and aerobic resistance[4],[5]. The training session applied by the coach was directed more to technical training and games. This affected the physical strength of poorly trained players[1],[6].

Cardiorespiratory endurance can be increased by a variety of training techniques, one of which is circuit training[1],[7]. Circuit training is a combination of several types of exercises carried out in several training posts [2]. At each training post, an athlete will perform a predetermined type of exercise[8]. One circuit training set is said to be complete if an athlete has completed training in all training posts according to the prescribed dose. The movements included in this circuit training are as follows: push-ups, sit-ups, vertical jumps, abdominal curls, back extensions, astride jumping over benches, pull-ups, bench stepping, burpe, shuttle run, thrust squats, side bend, skipping, and running on the spot[9].

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Material and Method

Participants: The population in this study was all male students who took extracurricular activities at a middle school in Denpasar, Bali. The sample in

this study was male students who took basketball as a preferred extracurricular activity. The sample used had to meet the following criteria: the participants were male middle school students who took basketball as an extracurricular activity, were aged 13–14 years, had low cardiorespiratory endurance of < 35 (poor), and did not take part in any cardiorespiratory resistance training program other than circuit training during the study. After each of these posts the students were given a break period of 15 to 20 seconds before proceeding to the next post. After completing one circuit, the students were also given a break period of 15 to 20 seconds.

Circuit training measures: In this study, some interviews and observations were carried out, and information related to age and some complaints experienced was generated. This would affect the daily physical activity and the training process and would let the researchers know whether the respondents observed were not too large. Several circuit training posts consisting of running on the spot, shuttle run, skipping, squats, push-ups, sit-ups for each set were established. This exercise was performed in 2 repetitions (sets) with a break time of 15–20 seconds between stages and between circuits.

a. Stage 1: Running on the spot. This training post lasted for 20 seconds.

b. Stage 2: Shuttle run. This training post lasted for 30 seconds (the students run back and forth and touched the predetermined boundary line).

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e. Stage 5: Push-up. This training post lasted for 30 seconds.

f. Stage 6: Sit-up. This training post lasted for 30 seconds.

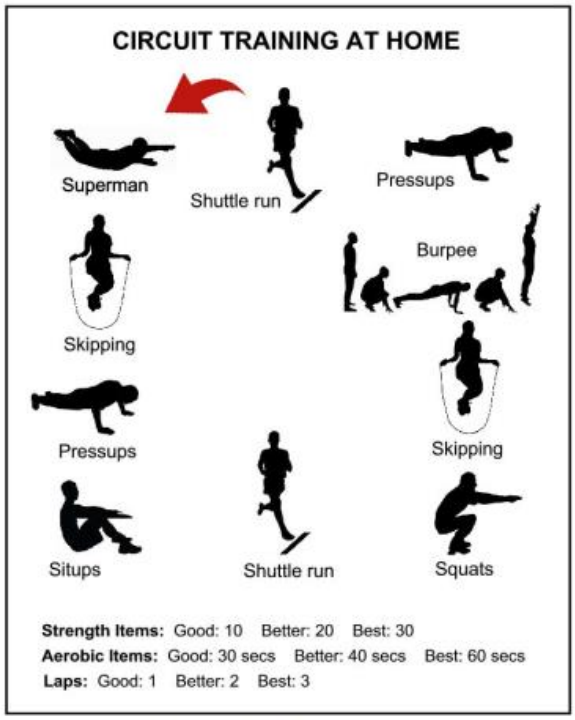

Fig. 1. Circuit trainning[9]

Statistical Analyses: This study used an experimental method with one-group pretest-post design. The data in the study were analyzed using SPSS. The analysis was conducted to describe the results of the research in the field without having to manipulate the facts. The data from the group weresubjected to a Shapiro-Wilk test at a significance level of 0.05. It was used to examine the average chest expansion before and after treatment in each group.

Finding and Results

Table 1 shows the number of respondents based on age:10 respondents (66.7%) were 13 years old, and the remaining 5 respondents (33.3%) were 14 years old.

Table 1: Age distribution of respondents

No	Age	Frequency	Percentage (%)
1	13	10	66,7
2	14	5	33,3
	Total	**15**	**100%**

Table 2 shows the number of respondents based on the VO_{2max} values obtained from the Balke test before the circuit training was performed: 5 respondents (33.3%) obtained values of < 35 and fell into the very poor category, 8 respondents (53.3%) obtained values of 35–37 and fell into the poor category, and 2 other respondents (13.3%) obtained values of 38–44 and fell into the fair category.

Table 2: Distribution of VO2 max values through Balke Test before being given Circuit Training

The VO2 max value in the balke test	Total		
	Category	F	Percentage (%)
< 35	Very poor	5	33,3
35 – 37	Poor	8	53,3
38 – 44	Fair	2	13,3
	Total	**15**	**100%**

Table 3 shows the number of respondents based on the VO_{2max} values from the Balke test after the circuit training was performed: 1 respondent (6.7%) obtained a value of < 35 and fell into the very poor category, 6 respondents (40.0%) obtained values of 35–37 and fell into the poor category, and 8 respondents (53.3%) obtained values of 38–44 and fell into the fair category.

Table 3: Distribution of VO2 max values through Balke Test after being given Circuit Training

VO2 max value	Total		
	Category	F	(%)
< 35	Very poor	1	6,7
35 – 37	Poor	6	40,0
38 – 44	Fair	8	53,3
Total		**15**	**100%**

Table 4 shows that the average VO_{2max} value obtained by a sample of 15 from the Balke test before the circuit training was performed was 35.68, the median was 36.2, the lowest value was 31.60, and the highest value was 39.60. Meanwhile, from the Balke test after the circuit training was performed to the same sample, the average VO_{2max} value was 38, the median was 38.5, the lowest value was 33.30, and the highest value was 44.

Table 4: Results of Measurement The average VO2 max value through the balke pre-test and post-test.

Variable		Mean	Median	Min	Max	%
Balke test	Pre-test	35,68	36,20	31,60	39,60	6,5%
	Post-test	38,00	38,50	33,30	44,00	

Table 5 shows the results of the normality test using the Shapiro-Wilk test. The pre-test VO_{2max} was 0.980. Because 0.980 > 0.05, the pre-test data were normally distributed. Meanwhile, the post-test VO_{2max} was 0.848. Because 0.848 > 0.05, the post-test data were normally distributed.

Table 5: Data Normality Test Results Measurement of VO2 max values through the balke test

Variable		Statistics	Sig,	Interpretation
Balke test	Pre-Test	0,982	0,980	Normal
	Post-Test	0,969	0,848	Normal

Table 6 shows that the paired t-test comparing the pre-test and post-test VO_{2max} values obtained from the Balke tests conducted on the sample yielded a significant result of 0.000 (0.000 < 0.05), indicating that there was a change in cardiorespiratory endurance after circuit training was performed.

Table 6: Results of paired t-test analysis

Results		Df	Sig	Information
Balke test	Pre-Test	14	0,000	There are significant differences
	Post-Test			

Discussion

Cardiorespiratory endurance in males aged 13–14 (adolescents) can increase if training is applied in accordance with a stipulated dosage or training load[10], [11].Age affects all components of physical fitness, and VO_{2max} plays an important role in respiratory fitness. VO_{2max} of children aged 8–16 years shows a progressive and linear increase in peak aerobic ability. Thus, it can be increased by applying active sports such as circuit training[12], [13], [14]. However, circuit training produces different levels of VO_{2max}, causingnon-optimal VO_{2max}achievement[6], [15]. Circuit training is designed to develop cardiorespiratory fitness, cardiovascular endurance, flexibility, strength, and muscle endurance [16]. This exercise has a number of advantages: it can be performed in a short time period;it can be applied to one person or a group of persons; and it does not require any complicated equipment [2]. Circuit training is designed to stimulate the cardiorespiratory organs, and, as a result, the resistance aspect is emphasized [17].

Some research studies reveal that male basketball players aged 10–12 years saw an increase of VO_{2max} after carrying out circuit training exercises for 6 weeks as well as average initial score and average final score by 7.68 ml/kg BW/minute (20.68%) [18],[3]. According to the American College of Sports Medicine in 2006, the target heart rate rangeone should achieve when conducting a circuit training exercise to experience cardiorespiratory benefits is 65%–90% of the maximum heart rate [15],[21]. This is in accordance with the results of the research conducted—that is,the dose used should be based on the size of the maximum heart rate to achieve changes in the cardiorespiratory aspect [19]. Recent studies related to exercises that have an effect on cardiorespiratory function have shown that breathing exercises are able to increase the amount of O_2 intake, for instance, chest expansion, with a p value of <0.05[20], [22]. Thus, the exercise also has an impact on the aerobic capacity of both sick patients and healthy people.

The results of this study show an increase in the cardiorespiratory endurance of male students taking basketball as an extracurricular activity based on the VO_{2max}values obtained from a Balke test ($p= 0.000$). The students were given circuit training 3 times a week for 4 weeks of meetings with a training load of 65%–90% of the maximum heart rate. Each circuit training treatment consisted of 2 sets of exercises, each of which consisted of 6 types of exercises that had to be carried out in each training post provided. Based on the VO_{2max} values before the circuit training was given to the sample, 20% of the respondents fell into the very poor category, 66.7% to the poor category, and 13.3% to the fair category. The 6 types of exercises were running on the spot, shuttle run, skipping, squats, push-ups, and sit-ups. This study's results are supported by previous research that was conducted on middle school students, which reveals that 6-week circuit training exercises on leg muscle strength could increase VO_{2max}[18], [23], [8].

The main limitation of our study is that we have yet to find anyother types of training comparative to circuit training for increasing the cardiorespiratory fitness of middle-school basketball players, thus we are in need of literature related to other types of aeorbic training. Therefore, more precisely, we recommend exercise to overcome the decline in cardiorespiratory fitness, for example, a decrease in the functional aerobic capacity.

Conclusions

From the observations conducted three times a week for four weeks, it was found that the provision of circuit training could increase the cardiorespiratory endurance of male students who took basketball as an extracurricular activity. However, in order to gain further insights regarding the improvement of cardiorespiratory fitness of long-term male basketball players, the sample size should be greater because the fitness level of each man may vary.

Conflict of Interest: The authors declare that there is no conflict of interest related to this study.

Source of Funding: The authors declare that there is no source of funding from anyone.

Ethical Clearance: The experiment was approved taken from by the Research Ethics Committee of Medical Faculty of Udayana University/Sanglah Hospital.

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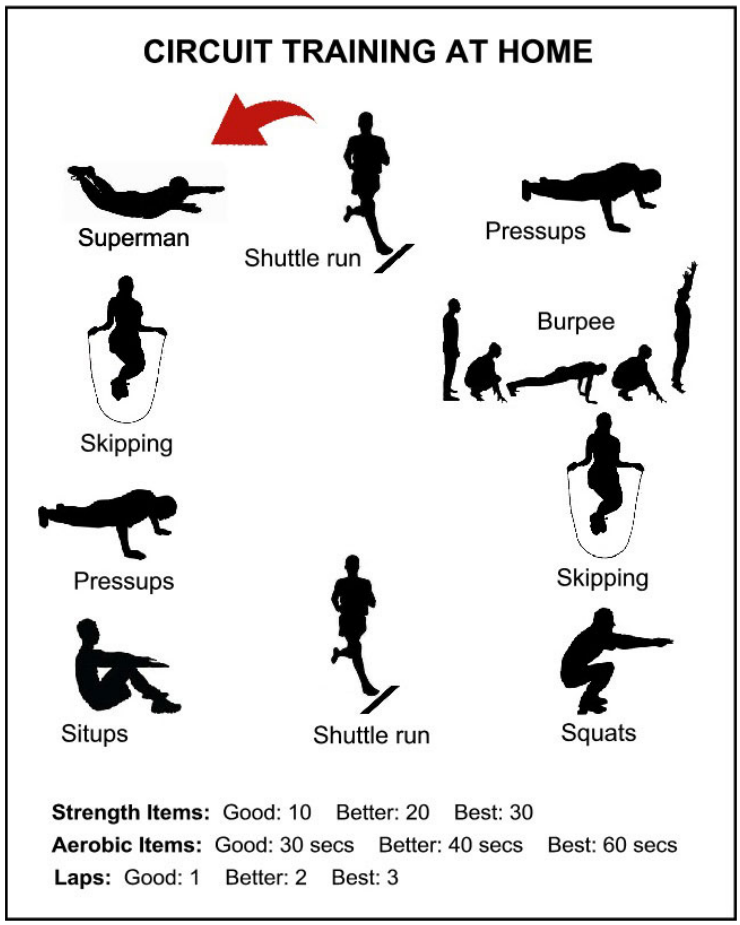

Fig. 1: Circuit trainning[9]

Statistical Analyses: This study used an experimental method with one-group pretest-post design. The data in the study were analyzed using SPSS. The analysis was conducted to describe the results of the research in the field without having to manipulate the facts. The data from the group were subjected to a Shapiro-Wilk test at a significance level of 0.05. It was used to examine the average chest expansion before and after treatment in each group.

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Balke test	Pre-test	35,68	36,20	31,60	39,60	6,5%
	Post-test	38,00	38,50	33,30	44,00	

Table 5 shows the results of the normality test using the Shapiro-Wilk test. The pre-test VO_{2max} was 0.980. Because 0.980 > 0.05, the pre-test data were normally distributed. Meanwhile, the post-test VO_{2max} was 0.848. Because 0.848 > 0.05, the post-test data were normally distributed.

Table 5: Data Normality Test Results Measurement of VO2 max values through the balke test

Variable		Statistics	Sig,	Interpretation
Balke test	Pre-test	0,982	0,980	Normal
	Post-test	0,969	0,848	Normal

Table 6 shows that the paired t-test comparing the pre-test and post-test VO_{2max} values obtained from the Balke tests conducted on the sample yielded a significant result of 0.000 (0.000 < 0.05), indicating that there was a change in cardiorespiratory endurance after circuit training was performed.

Table 6: Results of paired t-test analysis

Results		Df	Sig	Information
Balke test	Pre-test	14	0,000	There are significant differences
	Post-test			

Discussion

Cardiorespiratory endurance in males aged 13–14 (adolescents) can increase if training is applied in accordance with a stipulated dosage or training load[10], [11].Age affects all components of physical fitness, and VO_{2max} plays an important role in respiratory fitness. VO_{2max} of children aged 8–16 years shows a progressive and linear increase in peak aerobic ability. Thus, it can be increased by applying active sports such as circuit training[12], [13], [14]. However, circuit training produces different levels of VO_{2max}, causingnon-optimal VO_{2max}achievement[6], [15]. Circuit training is designed to develop cardiorespiratory fitness, cardiovascular endurance, flexibility, strength, and muscle endurance [16]. This exercise has a number of advantages: it can be performed in a short time period;it can be applied to one person or a group of persons; and it does not require any complicated equipment [2]. Circuit training is designed to stimulate the cardiorespiratory organs, and, as a result, the resistance aspect is emphasized [17].

Some research studies reveal that male basketball players aged 10–12 years saw an increase of VO_{2max} after carrying out circuit training exercises for 6 weeks as well as average initial score and average final score by 7.68 ml/kg BW/minute (20.68%) [18],[3]. According to the American College of Sports Medicine in 2006, the target heart rate rangeone should achieve when conducting a circuit training exercise to experience cardiorespiratory benefits is 65% –90% of the maximum heart rate [15],[21]. This is in accordance with the results of the research conducted—that is,the dose used should be based on the size of the maximum heart rate to achieve changes in the cardiorespiratory aspect [19]. Recent studies related to exercises that have an effect on cardiorespiratory function have shown that breathing exercises are able to increase the amount of O_2 intake, for instance, chest expansion, with a p value of <0.05[20], [22]. Thus, the exercise also has an impact on the aerobic capacity of both sick patients and healthy people.

The results of this study show an increase in the cardiorespiratory endurance of male students taking basketball as an extracurricular activity based on the VO_{2max}values obtained from a Balke test (p= 0.000). The students were given circuit training 3 times a week for 4 weeks of meetings with a training load of 65% –90% of the maximum heart rate. Each circuit training treatment consisted of 2 sets of exercises, each of which consisted of 6 types of exercises that had to be carried out in each training post provided. Based on the VO_{2max} values before the circuit training was given to the sample, 20% of the respondents fell into the very poor category, 66.7% to the poor category, and 13.3% to the fair category. The 6 types of exercises were running on the spot, shuttle run, skipping, squats, push-ups, and sit-ups. This study's results are supported by previous research that was conducted on middle school students, which reveals that 6-week circuit training exercises on leg muscle strength could increase VO_{2max}[18], [23], [8].

The main limitation of our study is that we have yet to find anyother types of training comparative to circuit training for increasing the cardiorespiratory fitness of middle-school basketball players, thus we are in need of literature related to other types of aeorbic training. Therefore, more precisely, we recommend exercise to overcome the decline in cardiorespiratory fitness, for example, a decrease in the functional aerobic capacity.

Conclusions

From the observations conducted three times a week for four weeks, it was found that the provision of circuit training could increase the cardiorespiratory endurance of male students who took basketball as an extracurricular activity. However, in order to gain further insights regarding the improvement of cardiorespiratory fitness of long-term male basketball players, the sample size should be greater because the fitness level of each man may vary.

Conflict of Interest: The authors declare that there is no conflict of interest related to this study.

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Ethical clearance: The experiment was approved taken from by the Research Ethics Committee of Medical Faculty of Udayana University/Sanglah Hospital.

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SETORAN TUNAI

82389 695618 00101[illegible]
SETOR TUNAI
340000047 BNI CABANG DENPASAR USD 227,46 RATE 14.250,00
TERBILANG :DUA RATUS DUA PULUH TUJUH KOMA EMPAT PULUH ENAM UNITED STATES DOLLAR
PENYETOR : BPK AGUNG WAHYU PERMADI , REK NO. 0577682699
BIAYA : BEBAS BIAYA
BERITA: COVER SIO AN AGUNG WAHYU PERMADI
SUMBER DANA : -
TUJUAN TRANSAKSI : -
34 - DENPASAR

PT. BANK NEGARA INDONESIA (PERSERO) Tbk
BNI
KANTOR CAPEM KAPAL

(Teller)

(Agung Wahyu, P.)
Penyetor

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Rp. 3.241.305,-

Kirim

200 x
14.250 =
2.850.000 +

Propisi

2.46 x
14.250 =
35.055 +

OBK

25 x
14.250 =
356.250 +

003

3.241.305 ◇

003

3.241.305 ◇

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BNI

Validasi :

Tanggal/ *Date* : 8/10/2019

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Remittance Application

Penerima/*Beneficiary*

☐ Penduduk/ *Resident* ☐ Bukan Penduduk/ *Non Resident*

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Bank Penerima/*Beneficiary Bank* : Lajpat Nagar, New Delhi

Kota/*City* : New Delhi Negara/*Country* : India

No. Rek./*Acc. No.* : 017706700002220

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☑ Perorangan/*Personal* ☐ Perusahaan/*Company*

☐ Pemerintah/*Government* ☐ *Remittance*

Nama/*Name* : Agung Wahyu Permadi

Nama Alias/*Alias Name* : Agung

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Telepon/*Phone* : +6281236169656

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Jenis Pengiriman/ *Type of Transfer*: ☐ LLG/*Clearing* ☐ Draft ☐ ______ ☐ RTGS ☐ SWIFT DLXBINBBDEL

Sumber Dana/ *Source of fund*

☐ Tunai/*Cash* ☐ Cek/*BG No.*

☐ Debit Rek./*Debit Acc. No.* 0517682699

Mata Uang/*Currency* : ☐ IDR ☑ USD ☐ ______

Jumlah Dana yang dikirim/*Amount Transfer* :

Jumlah/*Amount*	Kurs/*Rate*	Nilai/*Total Amount*	
200 USD			
Biaya/*Charge*	Valas/*Amount in Foreign Exchange*	Kurs/ *Amount*	Nilai/ *Total Amount*
Komisi/*Commision* Pengiriman/*Handling* Bank Koresponden/*Correspondent Bank*		Flop : 2.146 OBK : 25	
Jumlah Biaya/*Amount Charge* :			
Total yang dibayarkan/*Total Amount* :			

Terbilang/*Amount in Words* : dua ratus dollar America

Tujuan Transaksi (*Transaction Purpose*) : publikasi Artikel ilmiah (IJPHRD)

Berita (*Message*) : publication of scientific article (IJPHRD)

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Teller ID : 82389
Date : 08/10/2019
Time : 10:27:56

Sender's Reference:
:20:S10DPS00562319
Bank Operation Code:
:23B:CRED
Value Date/Currency/Interbank Settled Amount:
:32A:191008USD200,
Ordering Customer:
:50K:/05//682699
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BR DINAS POH GENDING PITRA
PENEBEL TABANAN BALI INDONESIA
Ordering Institution:
:52A:BNINIDJAXXX
Account With Institution:
:57D:LAJPAT NAGAR
NEW DELHI INDIA
SWIFT CODE DLXBINBBDEL
Beneficiary Customer:
:59:/017/06/00002220
RAMESH KUMAR SHARMA
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NO 1704 NEW DELHI INDIA
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:70:PUBLICATION OF SCIENTIFIC ARTICLES
Details Of Charges:
:71A:OUR

REFERENCE : S10DPS00562319

NO. TRX. : 82389 929546 96962 TRAN 08/10/2019 10:17:34
NO. REK. : 0000003400000047 SIMSEM GI VALAS
JUMLAH : USD 227.46- 1568
034 - DENPASAR

NO. TRX. : 82389 929546 96962 TRAN 08/10/2019 10:17:34
NO. REK. : 0348402001010001 KU YAKIK
JUMLAH : USD 200 1568
034 - DENPASAR

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NO. REK. : 0348404208610001 Pend.Provisi Kiriman U
JUMLAH : USD 2.46 1568
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NO. TRX. : 82389 929546 96962 TRAN 08/10/2019 10:17:34
NO. REK. : 0348404820100001 Pendapatan Restitusi B
JUMLAH : USD 25 1568
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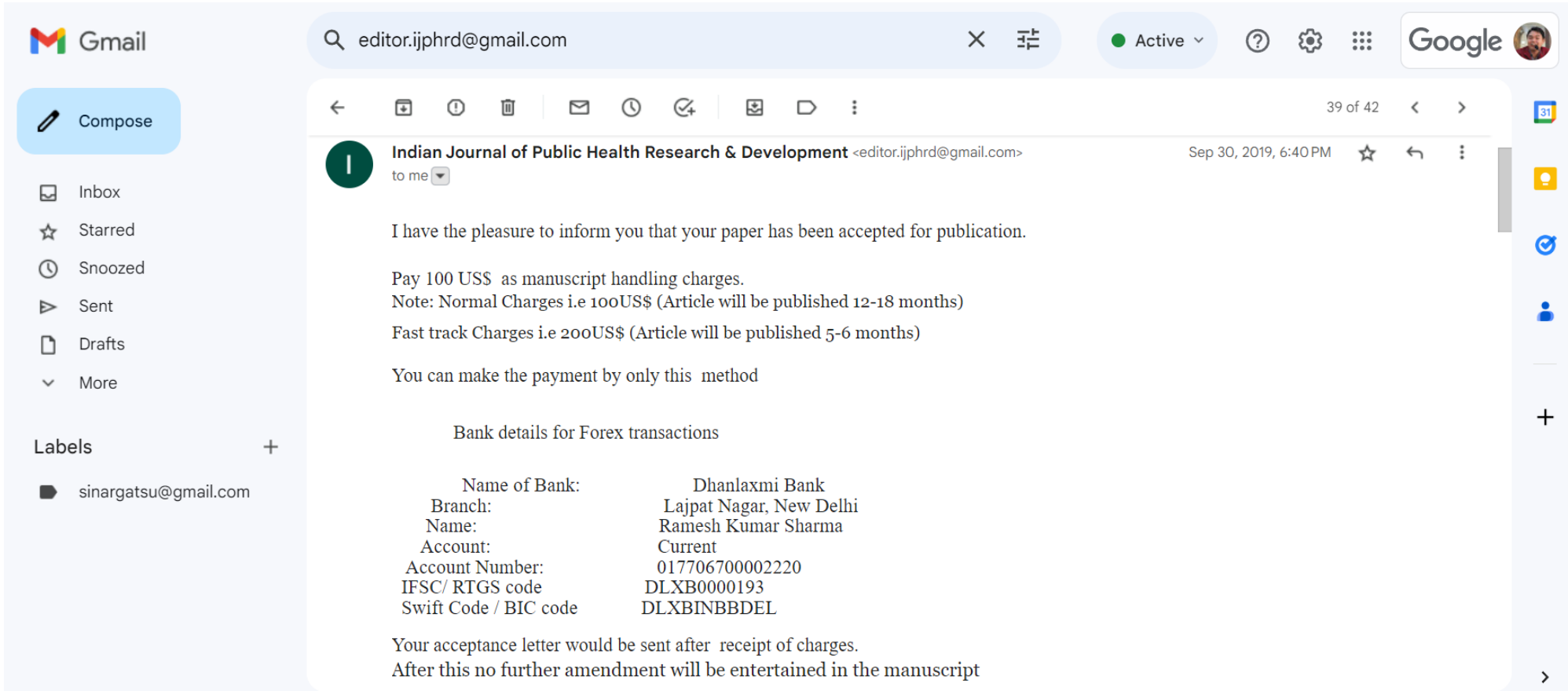
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